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DESIGNER'S HANDBOOK - INSTALLING THERMAL PIPE-LINE SYSTEMS. PAR--ETC(U)

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DESIGNER'S HANDBOOK
INSTALLING THERMAL PIPELINE SYSTEMS

by

I. P. Aleksandrov, I. V. Belyaykina, et al.

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Chapter 14.

PROTECTION OF CONDUIT/MANIFOLDS FROM ELECTRICAL CORROSION.

The electrical corrosion of metallic constructions appears in the form of the soil corrosion and corrosion, caused by stray currents.

The source of stray currents for underground metallic conduit/manifolds is in essence the rail network of urban streetcar and electrical railroads of direct current, in which the rails serve as return conductor (Fig. 14.1).

The branched from rail network current (return current of electric traction) through soil falls on the located near conduit/manifold, it passes along it and again it emerges into soil, striving to return to its source which can be the rail, suction point/item or the busbar/tire of the negative polarity of thrust substation.

Stray current in the places of entry and output/yield from metallic conduit/manifold causes its cathode and anodic polarization. The zone of entry is called cathode law, in which the metal of conduit/manifold has the negative potential of its relatively surrounding layers of soil. The zone of output/yield is called the anode zone in which the metal of conduit/manifold has the positive potential of its relatively surrounding layers of soil.

For underground metallic constructions danger represent the anode zones in which occurs the runoff of current into soil, which destroys metal.

The methods of the corrosion prevention of the underground conduit/manifolds of thermal networks are divided into passive and active.

The passive methods of protection are called the devices and the measures, which prevent the direct contact of underground structure with the environment and which increase contact resistance between them.

To passive methods they are related: the coating of the metallic surface of tubes with anticorrosion materials

with high dielectric properties; tubing in channels.

Active methods are called the devices, which create at construction such electrical conditions/mode during which the conduit/manifold acquires cathode potential earth referenced.

Are applied the following forms of the active protection of the conduit/manifolds: drainage, cathode and protector.

Drainage is a basic form of electrical protection. Cathode and protector protection in this case fulfill auxiliary function. These forms of protection as basic are applied predominantly during the soil corrosion.

In conjunction with the indicated forms of protection, is applied the electrical partitioning of conduit/manifolds with the aid of which increases the longitudinal resistance of construction.

Drainage protection is called safety method of the underground conduit/manifold of thermal networks from the corrosion, caused by stray currents, the means of the branch/removal of the latter from the shielded

conduit/manifold to its source (Fig. 14.2). Circuit is fulfilled in the form of direct or polarized electrodrainage.

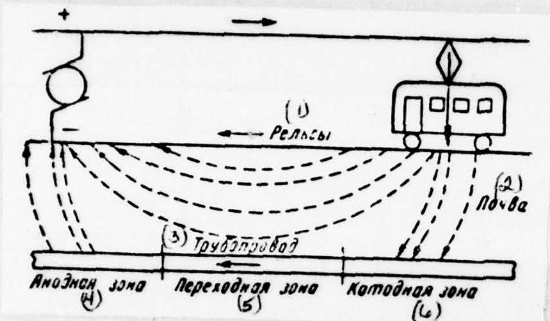

Fig. 14.1. Circuit of emergence of stray currents in underground conduit/manifold.

Key: (1). Rails. (2). Soil. (3). Conduit/manifold. (4). Anode zone. (5). Transition zone. (6). Cathode zone.

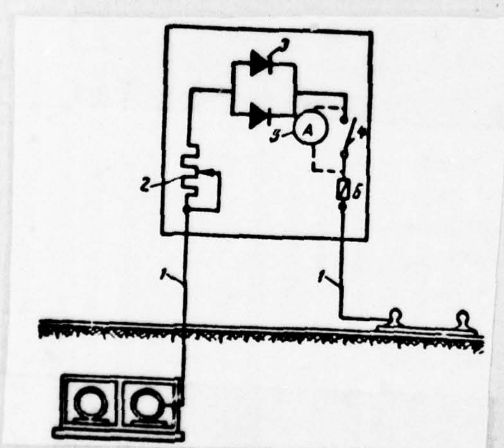

Fig. 14.2. Schematic diagram of drainage protection. 1 - drainage cable; 2 - rheostat; 3 - valve/gate; 4 - knife switch; 5 - ammeter; 6 - safety device/fuse.

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Direct/straight electrodrainage possesses bilateral conductivity, which limits its application/use. Polarized electrodrainage provides the one-way course of drainage current to source and has different design concept.

In some the unidirectional conductivity is reached because of valve semiconductive properties (type of drainage on germanium diodes PGD-200), in others is utilized the operating principle of electromagnetic contactors and polar relays (drainages of the type PED-AKKh, UPDU-57, etc.).

The polarized drainage is connected: in the networks of streetcar to the busbar/tire of the negative polarity of thrust substation, the suction point/item or to rails, in the networks of the electrified railroad - to rail with the unifilar circuits STsB, to suction point/item or to midpoint of path throttle/choke - with the double-rail track circuits STsB. The version of connection is determined in each specific case.

Cathode protection is called the protection of construction with which the negative potential of underground metallic construction with respect to the earth/ground is created with the aid of the special source of direct current - cathode station (Fig. 14.3). Current from anode grounding spreads in soil, it enters the shielded construction, polarizing it cathode. During this circulation of current, is destroyed the anode grounding of cathode protection.

The variety of cathode protection is intensive electrodrainage the principle of actipn of which is similar to the work of direct/straight drainage with the series connection of the cathode station where as anode grounding are utilized the rails of the electrified transport.

Intensive electric drainage is applied in the case of effect on the construction of several sources of stray currents or when construction is located in the zones of alternating/variable polarity.

As the sources of direct current in the device of intensive electrodrainage, are applied cathode stations of type KSS-3 and the selenium rectifiers of the type VSG-3M.

Protector protection is called the protection of metallic construction by the connection to it of metal with more negative electrochemical potential.

As a result of this connection, is formed the short-circuited galvanic cell tread/protector-conduit/manifold (Fig. 14.4).

By the cathode of this cell/element is the shielded conduit/manifold, the anode - tread/protector, by electrolyte - the soil, which surrounds conduit/manifold and tread/protector.

Tread/protectors are applied for the protection of underground metallic constructions from the soil corrosion and from the corrosion, caused by stray currents, if positive potential at construction does not exceed +0.3 v.

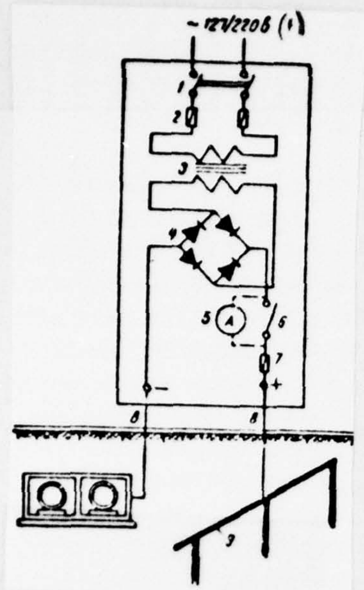
For an increase efficiency and a negative value of potential "tread/protector - the construction", and also for decrease in the corrosion of the alloy of its tread/protector places into greasing (mixture from magnesium

sulfate, gypsum and clay).

The partitioning of conduit/manifolds to the electrically isolated/insulated from each other sections is realize/accomplished with the aid of the insulating flanges (Fig. 14.5).

Partitioning, as a rule, is applied in the input/introduction of conduit/manifolds into the enterprises of the electrified transport and into the points of the intersection of conduit/manifolds with the rails of the electrified roads.

Partitioning applies also in the sections of output/yield the conduit/manifold of underground packing to metallic and reinforced-concrete bridges and overbridges.



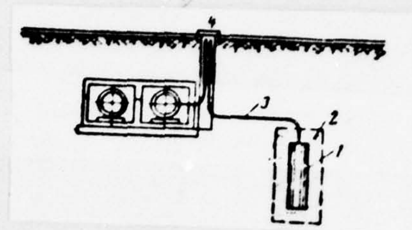


Fig. 14.3. Schematic diagram of cathode protection. 1 - cutout (switch) bipolar; 2 and 7 safety device/fuses; 3 - transformer; 4 - rectifier; 5 - ammeter; 6 - knife switch single-pole; 8 - drainage cable; 9 - anode grounding.

Key: (1). V.

Fig. 14.4. Schematic diagram of protector protection. 1 - tread/protector from magnesium alloy; 2 - greasing (filler); 3 - drainage cable; 4 - contact conclusicn.

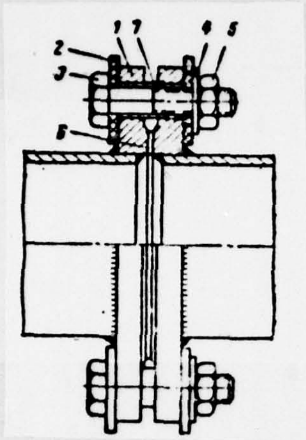


Fig. 14.5. Insulating flange. 1 - flange; 2 - insulating washer (Paronit); 3 - bolt; 4 - washer; 5 - nut; 6 - packing (Paronit); 7 - insulating bush (Paronit).

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The selection of the methods of protection can be produced on table 14.1, in which is given a comparative characteristic of safety devices.

The nomenclature of the used equipment in protection circuits of underground conduit/manifolds from electrical corrosion is given in table 14.2.

For monitoring of the state of thermal network during operation on the sections, equipped with the means of cathodic protection, in the thermoficated camera/chambers are organized inspection and measurement point/items (Fig. 14.6).

During the application/use of a drainage cathode protection, and sometimes and protector it is expedient to decrease the longitudinal electrical line resistance. For this purpose, in the sites of installation of gasket compensators and catches, are arranged the longitudinal shunting cross connections (Fig. 14.7, 14.8).

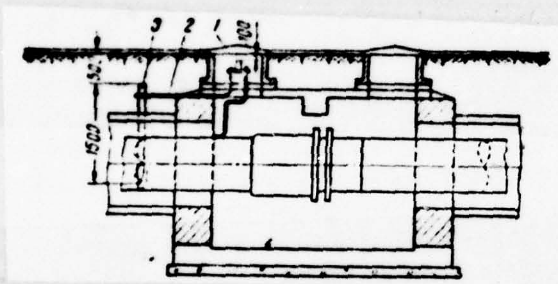
Presence of two and more jointly laid conduit/manifold with dissimilar thermal condition creates a potential difference between tubes. For compensation of potentials, are establish/installed the points between tubes (Fig. 14.9).

Table 14.1. Comparative characteristic of safety installation. (2). Field of application. (3). Advantages. (4). Shortcomings. (5). Polarized electrodrainage. (6). In zones with a difference of potentials, the "construction - rail" is greater than a potential difference "construction - the earth/ground" and positive or alternating potential "construction - rail". (7). One-way conductivity - is eliminated the course of return current to construction; the disconnection/cutoff of the protection with of the appearance of positive potential at the point of draining. (8). During the appearance of positive potential at the point of the draining of construction, it is not shielded. (9). Intensive electrodrainage. (10). In the zones of the effect of several sources of stray currents. (11). Constancy of negative potential at the point of draining. (12). Appearance of the additional stray currents; the increase in the output/yield of current from rails, which facilitates from the intensive wear. (13). Station of cathode protection. (14). In the zones of small in absolute value positive potentials. (15). 24-hour action of protection in accordance with the assigned/prescribed conditions/mode. (16). The emergence of additional wandering currents. (17). Tread/protectors. (18). For relieving the small on extent anode zones with positive potential to +0.3 V. (19).

TABLE 14.1

(1) Наименование защитной установки	(2) Область применения	(3) Достоинства	(4) Недостатки
Поляризованный электродренаж (5)	(6) В зонах при разности потенциалов «сооружение — рельс» больше разности потенциалов «сооружение — земля» и положительном или знакопеременном потенциале «сооружение — рельс»	(7) Односторонняя проводимость — исключается протекание обратного тока на сооружение; отключение защиты при появлении положительного потенциала в точке дренирования	(8) При появлении положительного потенциала в точке дренирования сооружение не защищается
(9) Усиленный электродренаж	(10) В зонах влияния нескольких источников блуждающих токов	(11) Постоянство отрицательного потенциала в точке дренирования	(12) Появление дополнительных блуждающих токов; увеличение выхода тока из рельсов, способствующее их усиленному износу
(13) *Станция катодной защиты*	(14) В зонах небольших по абсолютной величине положительных потенциалов	(15) Круглосуточное действие защиты в соответствии с заданным режимом	(16) Возникновение дополнительных блуждающих токов
(17) Протекторы	(18) Для снятия небольших по протяженности анодных зон при положительном потенциале до +0,3 *в*	(19) Простота конструкции	(20) Неэффективность в случаях плохого состояния или отсутствия изоляционного покрытия на сооружении
(21) Изолирующие фланцы (электросекционирование)	(22) На вводах сооружений в здания и на объекты электрифицированного транспорта; при пересечениях с рельсами электрифицированных дорог; при подъеме на мосты, путепроводы и т. д.	(23) Повышение продольного сопротивления сооружения и уменьшение величины блуждающих токов	(24) Возможность повышения коррозийного процесса

Simplicity of construction. (20). Ineffectiveness in the cases of poor state or absences of insulation coating on construction. (21). Insulating flanges (electric sectioning). (22). During the input/introductions of constructions into buildings and on the object of the electrified transport; during intersections with the rails of the electrified roads; with ascent to bridges, overbridges, etc. (23). Increase in the longitudinal resistance of construction and decrease in the value of stray currents. (24). Possibility of an increase in the corrosion process.



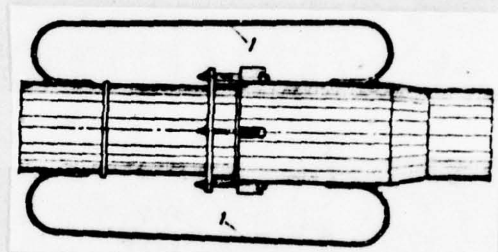


Fig. 14.6. Inspection and measurement point/item in thermoficated camera/chamber.
1 - measurement points; 2 - check conductor (steel wire 4 - mm in diameter in polyvinyl chloride tube with diameter of 5.5 mm; 3 - electrode (steel tube 50 mm in diameter, 1 = 1.5 m.
Fig. 14.7. Electrical jumpers on gasket compensator. 1 - steel strip 25 x 4 mm in bituminous greasing.

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For an increase in the effectiveness of the active methods of protection in channel-free packing, is applied the reliable anticorrosive coating of the external surface of pipes, which possesses dielectric properties. With packing in channels, are applied special pillows under movable supports with the electro-insulation which is made in the form of several layers of Paronit. In foreign practice is applied the device of the cradles in the form of glass block.

In the sites of installation of shield and skeleton fixed supports, is provided for the tubular insulation from supporting structure with the aid of Paronit packing (Fig. 14.10).

The application/use of supports, which possess dielectric properties, considerably increases the zone of the electrical protection of one installation. In the case of the adverse effect of the active protection of thermal networks on other underground communications, active protection in the form of polarized electrodrainage is fulfilled complexly for an entire group of the communications which are connected together with potential leveling cross connections.

Table 14.2. Nomenclature of the used equipment in protection circuits.

(1) Электродренажной			
(2) Наименование	(3) Тип	(4) Средний дренажный ток в а	(5) Допустимое обратное напряжение в в
(6) Поляризованный электродренаж	ПГД-200	200	50
То же	УПДУ-60	200	100
(7) »	ПДУ-62	300	100
»	ПД-3А	500	100
Усиленный дренаж[1] (8)	УД-2400		

(9) Катодной				
(2) Наименование	(3) Тип	(10) Напряжение переменного тока в в	(11) Напряжение выпрямленного тока в в	(12) Выпрямленный ток в а
(13) Катодная станция	КСС-1	127/220	24	12.6
То же	КСС-2	127/220	24	25
» (7)	КСС-3	127/220	24	50
»	КС-[illegible]	110/220	40	20
»	КСГ-[illegible]00-1	110/220	50	10
»	КСГ-[illegible]00-1	110/220	60	20
То же[1] (7)	ВСГ-3м	220	3.5; 4.5; 6	(14) до 200
Селеновый выпрямитель (15)	ВСА-5	110/127/220	64	12

(16) Протекторной			
Наименование (2)	Тип (3)	(17) Вес в кг	(18) Средняя токоотдача в ма
(19) Протектор из магниевого сплава МЛ-4 или МЛ-5[1]	МГА	10	47.5

Key: (1). Electroosmotic dewatering. (2). Designation. (3). Type. (4). Neutral drainage current in a. (5). Permissible reverse/inverse voltage in V. (6). Polarized electrodrainage. (7). The same. (8). Intensive drainage [1].

FOOTNOTE [1]. It is applied only in the circuits of the

intensive drainage. ENDFOOTNOTE.

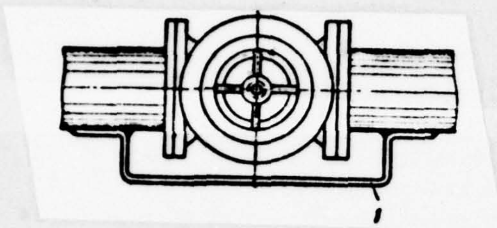
(9). Cathode. (10). Voltage of alternating current in V. (11). Voltage of rectified current in V. (12). Rectified current in a. (13). Cathode station. (14). to. (15). The selenium rectifier. (16). Protector. (17). Weight in kg. (18). Average current output in mA. (19). Tread/protector from magnesium alloy ml-4 or ml-5 [2].

FOOTNOTE [2]. Tread/protector is establish/installed in greasing (filler), the composition of which includes:

(1) сернокислый магний	17 кг (1А)
(2) гипс	17 »
(3) глина строительная сухая	30 »

Key: (1). magnesium sulfate. (1A). kg. (2). gypsum. (3). clay construction is dry.

The indicated materials are mixed with addition 14 l of water up to doughy mass. ENDFOOTNOTE.



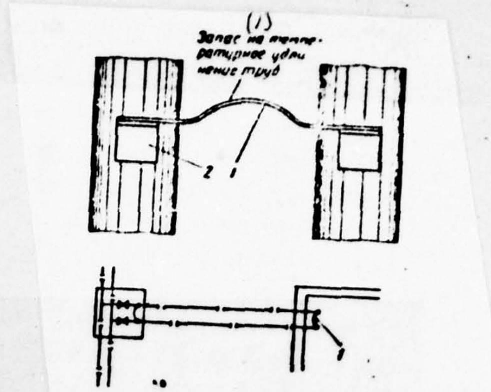


Fig. 14.8. Electric jumpers on catch. 1 - steel strip 50 x 4 mm in bituminous greasing.

Fig. 14.9. Electric jumper between tubes. 1 - steel strip 50 x 4 mm; 2 - angle 50 x 50 x 5, L = 50 mm (2 pcs.).

Key: (1). West for the temperature elongation of tubes.

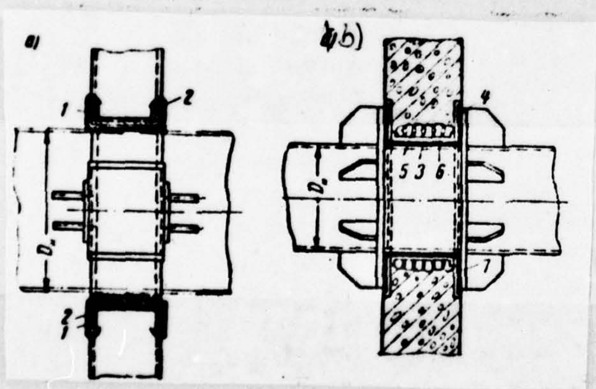


Fig. 14.10. Fixed support with electro-insulation of tube.

a) support on framework/body; b) panel support; 1 - Paronit packing by thickness 1 mm; 2 - tin stainless, 1 mm; 3 - paronit cylinder; 4 - Paronit packing; 5 - asbestos cord; 6 - cylinder of two layers of bituminous-rubber waterproofing material; 7 - packing of twc layers of bituminous-rubber waterproofing material.

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The development of the project of protection from electrical corrosion is produced on the basis of special electrical corrosive research. The first stage of research is the determination of corrosion conditions for the route of thermal networks on the basis of the information about the existing and design/projected installations which can serve as the sources of stray currents and electrical measurements in characteristic points. The measurements of a potential difference the "rail of the electrified transport - the earth/ground" are made on the electrified railroad through 300-400 m with parallel packing and in the points of intersection, but on tram line through 200-300 m in the points of intersection and near the suction point/items. The measurements of a potential difference the "busbar/tire of

negative polarity - the earth/ground" are made during the closely spaced thrust substations. According to the route of thermal network, is determined the specific resistance of soil. For the effective thermal networks measure a potential difference "conduit/manifold - earth/ground" and the "construction - earth/ground" (with parallel packing with other communications and during intersections).

The period of potential measurements "rail - the earth/ground", "heating main is the earth/ground" and the "construction - the earth/ground" in each point/item of measurement is received as 10 min, but the "busbar/tire of negative polarity is the earth/ground" -4-6 hours.

In characteristic (in corrosion sense) point/items at construction, are produced the multihour measurements, a quantity and duration of which is explained by local conditions.

Table 14.3.

(1) Наименование	(2) Обозначение	(3) Назначение	(4) Погрешность в %	(5) Пределы измерения	(6) Исполнение
(7) Многопредельный ампервольтметр	М231	(8) Для измерения силы тока и напряжения в цепях постоянного тока	±1.5	(9) По току: 0,005—0—0,005 *а* 0,05—0—0,05 » 0,1—0—0,1 » 1—0—1 » 10—0—10 » по напряжению: 75—0—75 *мв* (10a) 0,5—0—0,5 *в* 1—0—1 *в* (10b) 5—0—5 *в* 10—0—10 *в* 100—0—100 *в*	(10) Переносный, изготовляется в металлическом штампованном корпусе
(11) Самопишущий многопредельный милливольтмикроамперметр	Н373-2	(12) Для измерения и записи малых токов и напряжений	+1,5	(13) По току: 0,5—1,5—5—15— —50—150 *мка* 0,5—1,5—5—15— —50—150 *ма* (15) (16) по напряжению: 5—15—45—75— —150 *мв* (16a) 0,5—1,5—5—15— —50—15 *в* (10b)	(14) Переносный, изготовляется в металлическом корпусе. Питание от сети переменного тока 127/220 *в*
(17) Самопишущий многопредельный микроампер - милливольтметр с автономным блоком питания	Н373-3	(18) Для измерения и записи малых токов и напряжений	+2,5	То же (18a)	(19) Переносный, изготовляется в металлическом корпусе. Питание от блока П373 и от сети
Измеритель (20) заземления	МС-08	(21) Для измерения сопротивления заземляющих устройств и удельного сопротивления грунта	±1,5	0—1000 *ом* (22) 0—100 » 0—10 »	(23) Переносный, изготовляется в пластмассовом корпусе
Ампервольтметр (24)	Ц20	(25) Для измерения силы и напряжения постоянного тока, напряжения переменного тока и сопротивления постоянному току	(26) +4 при измерении тока и напряжения (28) ±2,5 при измерении сопротивления	(27) Постоянный ток: 0—300 *мка* 0—3 *ма* 0—300 » 0—750 » (29) напряжение постоянного тока: 0—1,53 *в* (10b) 0—68 » 0—308 » 0—120 » 0—600 » (30) сопротивление: 0—500 *ом* (22) 0—0,5—5 *ком* (31) 0,5—50 » 5—500 »	То же (18a)

Key: (1). Designation. (2). Designation. (3). Designation/purpose. (4). Error in o/o. (5). Capacities. (6). Performance. (7). Multirange ampere-voltmeter. (8). For the measurement of the current strength and voltage in direct-current circuits. (9). On current. (10). Movable, is manufactured in the metal die-forged/stamped housing. (10a). mV. (10b). V. (11). Recording multirange millivolt microammeter. (12). For measurement and recording of low currents and voltages. (13). On current. (14). Movable, is manufactured in metal housing. Feeding from the network of alternating current 127/220 V. (15). mA. (16). on voltage. (16a). mV. (17). Recording multirange microampere - millivoltmeter with autonomous power supply unit. (18). For measurement and recording of low currents and voltages. (19). Movable, is manufactured in metal housing. Feeding from the unit P373 and from network. (20). Meter of grounding. (21). For the measurement of the resistance of the grounding devices and specific resistance of soil. (22). ohm. (23). Movable, is manufactured in plastic housing. (24). Ampere-voltmeter. (25). For the measurement of force and DC voltage, voltage of alternating current and direct-current resistance. (26). during the measurement of current and voltages. (27). Direct current. (28). during resistance measurement. (28a). μA. (29). DC voltage. (30). resistance. (31). kiloohm.

In the danger zone which has been disclosed, synchronous measurements of potentials are conducted at a number of points during a certain period of time under assigned conditions. This organization of electrometric work permits obtaining comparable measurement results from which conclusions can be drawn concerning the distribution of potentials in the danger zones, the boundaries of these zones, and the mutual effect of underground structures.

When measuring potential differences, a copper sulfate electrode is used to accomplish contact with the ground with the potential value below 1 V, and a steel electrode above 1 V.

As a practical matter, measurements of potentials are accomplished by visual observation of instrument readings (by voltmeters of the magnetoelectric system with large internal impedance). A considerable simplification of the measurement procedure with a simultaneous increase in the quality and reliability of the results obtained is introduced by the automatic recording of the measured values with the use of recorders.

The next stage in corrosion investigations is experimental testing on a thermal system which has been laid to define in detail the optimum parameters of cathodic protection.

The points for connecting experimental electrodrainage are selected depending on the configuration of the thermal system to be protected and the location of the source of stray currents.

To simplify tests of protection, the drainage cable is connected to the heat conductor in accessible places (in chambers and so forth).

A flexible copper cable in a rubber hose with a cross section of at least 100 mm^2 is used in the test drainage.

The effectiveness of the protective action of the experimental drainage is determined from the results of several potential measurement cycles along the route of the thermal system with the disconnected and connected protective unit with a change in drainage conditions. The value of the drainage current is recorded in para lel with the measurements of potentials.

If the measurements established that the zone of protective action of the experimental electrodrainage with maximum current is

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not extended to the protected section of the thermal system, possible versions of shifting the drainage points are tested or additional drains are connected.

To refine the parameters of cathodic protection, an experimental cathodic station is used which consists of a dc source (rectifier), temporary anodic ground, and connecting cables. The cathodic station is connected to a pipeline at the point with greatest positive potentials.

In the installation of an anodic ground, the effect of adjacent underground structures should be considered. A temporary anodic ground consists of several tubes with a diameter of 50-70 mm and a length of 2-3 m. Existing metal structural elements (side shoots of supports, metal fences, and so forth) which do not have contact with underground structures can be used as temporary anodic grounds.

Determination of the effectiveness of cathodic protection is reduced to measurements similar to the test of electrodrainage.

The optimum parameters for a fixed unit are selected with different operating modes of the experimental cathodic station.

The concluding stage of the electrical corrosion investigations is the determination of the effect of cathodic protection on adjacent underground metal structures by measurements on underground structures with the protection of the thermal system turned off and on in its selected operating mode. The decision on the joint or separate protection is made depending on the results of the check.

The materials of the investigations are processed and put out in the form of diagrams and graphs in a "Separate Report on Electrical Corrosion Investigations." The report gives a conclusion concerning the degree of corrosion danger and recommendations for protective measures.

The equipment and instruments employed in the accomplishment of electrical investigations are presented in Table 14.3.

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Chapter 15.

STRUCTURES.

15.1. Basic condition/positions.

The calculation of strength and stability of the constructions of thermal grid/networks is produced due to limiting condition on the most unfavorable possible calculated combinations of effects and loads, determined taking into account the order of building, the production methods of work and technological loads in the launching phases and operation of pipelines.

The basic combinations of loads on structures are composed of dead weight, loads from pipelines and equipment the pressure of soil and of ground water and loads from ground-based transport. Additional - from the loads, entering the basic combinations, with the addition of load due to wind and loads from temperature effect on structure. Special - from the additional combination of loads and special effect (for example, the seismic load).

During taking into account the additional or special loads of the value of design loads, besides dead weight, they are multiplied by the coefficient, equal: upon consideration of additional combinations - 0.9, while upon consideration of special combinations - 0.8.

The calculation of the elements of the structures of thermal grid/networks must be produced on the appropriate technical specifications and norms with the necessary testing of the stability of construction as a whole.

During the planning of composite reinforced-concrete cell/elements, one should approach the limitation of their

weight within limits 5 t. The size/dimensions of composite cell/elements must not exceed the dimensions, establish/installed for transportation on streets in the populated areas.

The depth of the laying of foundation level of above-grade supports and supports of piers calculates of the stability of base/root and by conditions of heaving soil with freezing SNiP II B-1-62).

Base/root under the foundations of supports is designed from the first limiting condition (according to bearing capacity) or due to the second limiting condition (on strains) depending on the form of soils and admissibility of the nonuniform upsetting of two nearest supports under pipelines or pier (SNIP II B.1-62).

The division of soils according to granulometric composition, density, the number of plasticity and consistency, and also standard pressures on the ground of base/root, the standard and design characteristics of sand and clay soil (cohesion/coupling, the angle of internal friction and the modulus of elasticity) are accepted according to the tables of SNIP II-B.1-62.

15.2. Underground packing.

The composite constructions of channels for underground pipe laying are packed to the leveling sand layer by thickness 100 mm. In the presence of cheap crushed stone or gravel, training/preparation can be fulfilled from these materials.

In order to avoid the carrying out of sand training/preparation from under the bottom of channels by surface water during installation, it along the length of trench through each 10-20 m (depending on the slope/transconductance of the gradient/drafts of the bottom of channels) are recommended to interrupt by transverse locks with width 40-60 cm from local clay soil. The filling of trenches under passages and roads with the improved coatings one should fulfill from the packed unsettled soils.

The filling channels packed on loess soils, fulfills

from the dense weakly-filtering soils with their necessary packing/seal. Application of the drain/venting fillings in loess soils can lead to the moistening of base/root and its sag.

The planning of the earth/ground on route must provide the branch/removal of surface water from the zone of pipe laying.

The surfaces of the composite reinforced-concrete constructions of the channels and camera/chambers, which come into contact with soil, in all cases must be cover/coated with coating waterproofing.

During the layout of the underground structures of thermal grid/networks standard time/temporary loads from the rolling stock of railroads and columns of automobiles one should determine in accordance with indication SNIP II-D.7-62. Loads from the rolling stock of railroads are accepted according to class CK with K, equal to 14.

Loads from the columns of automobiles are accepted in the form of load N-30 from two columns, and with packing within quarters - in the form of load N-10 (table 15.1).

The distribution of vertical load from the wheels of automobiles during the sinking of the top of constructions to 1.2 m is accepted within the limits of concrete road surface at an angle of 45°, and in soil - at an angle of 30° to vertical line.

During imposition on each other of the areas of pressure from separate wheels the intensity of pressure is accepted to the equal total load from these wheels, in reference to the combined area of pressures, $F = ab$ $м^2$ (Fig. 15.1).

With the sinking of the top of constructions for 1.2 m and more standard vertical load of the columns of automobiles, they accept equal to 2 t/m².

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Horizontal load on the underground structures of thermal grid/networks from mobile standard time/temporary loads, which are found within the limits of the prism of the collapse of soil, is determined from the formula

$$P_{г} = P_{в}\,\mathrm{tg}^2\left(45° - \frac{\varphi_{н}}{2}\right)\ m/м^2, \qquad (15.1)$$

the t/m^2

where P_r is standard horizontal pressure in tons on 1 m^2 of vertical plan of construction;

$P_в$ - Vertical pressure from standard time/temporary load at depth h (Fig. 15.2);

$\varphi_н$ - a standard angle of the internal friction of soil in deg is accepted according to SNIP II-B.1-62.

Load factor for mobile time/temporary loads is accepted from the rolling stock of railroads n = 1.3; from the columns of automobiles n = 1.4.

Dynamic coefficient $(1 + \mu)$ for mobile time/temporary loads is accepted: with the depth of the laying of the top of the underground structures of thermal grid/networks is not less than 0.5 m $(1 + \mu) = 1$; in the absence of filling $(1 + \mu) = 1.3$; at the intermediate values of the height/altitude of filling - on interpolation.

Standard loads from the pressure of soil- on the underground structures of thermal grid/networks one should determine from the formulas:

vertical

$$q_{в} = \gamma_0 h_0 \ m/м^2, \qquad (15.2)$$

horizontal

$$q_{г} = \gamma_0 h \ \mathrm{tg}^2 \left(45^\circ - \frac{\varphi_н}{2}\right), \qquad (15.3)$$

where $q_в$ is vertical load from the pressure of soil on the horizontal projection of construction in t/m²;

$q_г$ - horizontal load from the pressure of soil on vertical plan of construction in t/m²;

γ_0 - the specific weight of soil in t/m³;

h_0 - a distance from the top of construction to the earth's surface in m (Fig. 15.3);

h - distance from the section/cut in question to the earth's surface in m;

$\varphi_н$ - the standard angle of the internal friction of soil in degrees are accepted in accordance with the indications of SNIP II B.1-62.

Load factor for loads from the pressure of soil are taken as equal to 1.2 (0.8) [1].

FOOTNOTE [1]. The indicated in brackets value of load factor is taken when decrease in the loads causes a deterioration in the work of constructions. ENDFOOTNOTE.

Horizontal pressure $q_{г.в}$ from ground water on the walls of the channels, tunnels, camera/chambers and other constructions on depth y from its horizon/level determine taking into account the weighhing action of water on soil by the formula

$$q_{г.в} = y\left[1 - \frac{tg^2\left(45^\circ - \frac{\varphi}{2}\right)}{1 - \varepsilon}\right] t/m^2; \quad (15.4)$$

where ε - the void ratio of soil;

y - distance from the highest level of ground water to the section/cut in question.

Table 15.1. Basic indices for automobiles according to circuits N-30 and N-10.

(1) Наименование показателей	(2) Единица измерения	(3) Схема нагрузки		
		Н-30	Н-10	
			(4) утяжеленный автомобиль	(5) нормальный автомобиль
(6) Вес нагруженного автомобиля	т	30	13	10
(7) Давление на заднюю ось	»	2×12	9,5	7
» » переднюю ось	»	6	3,5	3
(8) Ширина заднего ската	м	0,6	0,4	0,3
» переднего ската	»	0,3	0,2	0,1
(9) Длина соприкасания ската с покрытием проезжей части (по направлению движения)	»	0,2	0,2	0,2
(10) Ширина кузова	»	2,9	2,7	2,7
(11) База автомобиля	»	6+1,6	4	4
(12) Ширина колеи по серединам скатов	»	1,9	1 7	1,7

Key: (1). Designation of indices. (2). Unit of measurement. (3). Load diagram. (4). the weighted automobile. (5). normal automobile. (6). Weight of the loaded automobile. (7). pressure on rear axle/axis. Pressure is the front axle. (8). Width of rear slope. Width of the forward slope. (9). Length of the contact of slope with the coating of

transient part (in the direction of motion). (10). Width of body. (11). Base of automobile. (12). Track gauge on the middles of slopes.

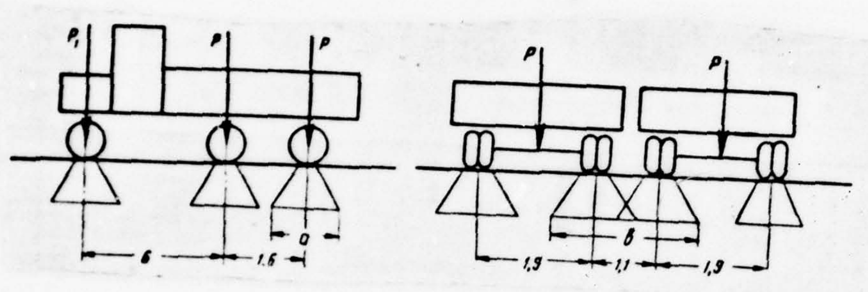

Fig. 15.1. Loading diagram in soil.

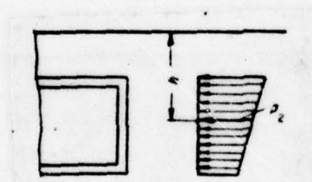

Fig. 15.2. Horizontal load diagram on underground structure from transport.

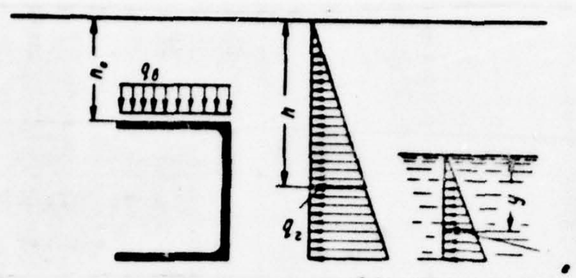

Fig. 15.3. Load diagram on ground construction from soil and ground water.

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Impassable channels.

Impassable channels are fulfilled from composite concrete and reinforced concrete. At small length of route and with low diameters of the tubes of the wall of impassable channels, it is allow/assumed to fulfill of well fired common brick of brand 100.

Impassable channels are divided into unicellular, bicellular and multicellular.

In the channels of a series of TS-01-01 (Fig. 15.4) wall, they are fulfilled from composite concrete blocks or from brick, bottom - from concrete slabs or monolithic concrete. Channels overlap with flat/plane composite reinforced-concrete plate/slabs. The height/altitude of channels in world/light from 190 to 1060 mm, width is from 250 to 1800 mm. The consumption of materials for walls, bottom and the overlap of unicellular channels on TS-01-01 is given in table 15.2, 15.3.

In 1963 by GOSSTROY of the USSR was introduced into action a series of IS-01-04 standardized composite reinforced-concrete impassable channels. Channels are designed to the action of automobile load according to class N30 and of wheel load according to class NK-80 with the sinking of the top of overlap from 0.7 to 2 m.

By construction the channels are divided into two types. The first type is assembled from chute cell/elements

and is designated by brands KL and KLS (Fig. 15.5a, b and 15.6a, b), the second - from composite reinforced-concrete plate/slabs is designated by brands KS (Fig. 15.7a, b). The channels of brands KL by height 300, 450 and 600 mm are assembled from the chute cell/elements, overlapped by removable flat/plane plate/slabs. Channels by height 900 and 1200 mm install from the chute cell/elements, packed to each other.

In channels of the type KS composite wall panels are establish/installed in the groove/slots of the composite plate/slabs of bottom and assemble in one piece by concrete M-300 on small crushed stone.

Marking, overall dimensions and the consumption of materials for the channels of brands КЛс and KS are given in table 15.4, 15.5, 15.6.

The nomenclature of the composite articles, developed in series IS -01-04, is given in table 15.7, 15.8.

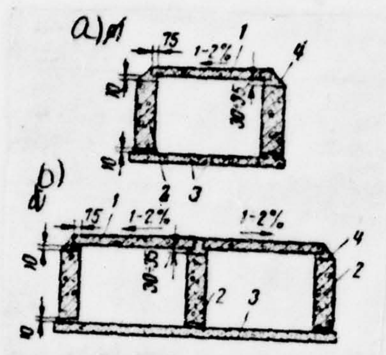

Fig. 15.4. Channel with concrete walls on TS-01-01, a) unicellular; b) bicellular; 1 - composite reinforced-concrete flooring slabs; 2 - wall blocks; 3 - plate/slab of base/root or concrete training/preparation; 4 - cement mortar.

Table 15.2. Consumption of materials for walls on 100 lin. m. of unicellular channels.

(1) Высота канала в свету в мм	(2) Стеновые бетонные блоки		(3) Кирпичные стенки	
	(4) расход материалов			
	(5) бетона в м³	(6) стали в кг	(7) толщина в мм	(8) объем в м³
190	4	—	120	4,6
235	5,2	—	120	5,6
310	7	—	120	7,4
385	8,8	34	120	9,2
460	10,6	34	120	11
535	12,4	34	250	26 8
610	14,2	34	250	30,5
685	21,2	34	250	34,3
760	23,6	34	250	38
835	26	34	250	41,8
985	38,4	34	250	49,3
1060	41,4	34	250	53

Key: (1). Height/altitude of channel in world/light in mm. (2). Wall concrete blocks. (3). Brick walls. (4). the consumption of materials. (5). Concrete in m³. (6). steel in kg. (7). thickness in mm. (8). volume in m³.

Table 15.3. Consumption of materials for coating and bottom for 100 running meters of unicellular channels with concrete walls.

(1) Ширина канала в мм	(2) Плиты перекрытия		(3) Плиты основания	
	(4) бетон в $м^3$	(5) сталь в кг	(4) бетон в $м^3$	(5) сталь в кг
250	2.7	49	6,4	
300	2.7	49	8,2	
350	3,3	80	8,2	
400	3,3	80	8,2	
450	3,8	151	8,2	
500	3.8	151	10	
550	4.4	228	10	
600	4.4	228	10	
700	5,8	264	12,8	
800	6,4	410	12.8	(6) Плиты не армируются
900	8,2	576	12,8	
1000	10,2	703	14.6	
1100	12,8	778	16.4	
1200	13,8	834	16,4	
1300	17,7	888	18,2	
1400	18,6	1252	18,2	
1500	21.4	1316	18,2	
1600	22,6	1388	20	
1700	25,8	1800	22,8	
1800	31	1546	22,8	

Key: (1). Width of channel in mm. (2). Plate/slabs of overlap. (3). Plate/slabs of base/root. (4). concrete in m (5). steel in kg. (6). Plate/slabs are not reinforced.

Table 15.4. The consumption of materials on 3 lin. m. of the unicellular channels of brands KL and KLs (See Fig. 15.5a; 15.6a).

(1) Марка канала	(2) Габариты каналов в м		(3) Бетон сборный (в $м^3$)	(4) Сталь (в кг)
	A	H		
КЛ60-30	0,6	0,3	0,47	29,2
КЛ60-45	0,6	0,45	0,53	30,6
КЛ90-45	0,9	0,45	0.76	56,2
КЛ60-60	0,6	0,6	0,61	40,1
КЛ90-60	0,9	0.6	0.84	58
КЛ120-60	1,2	0,6	1,12	101,9
КЛ150-60	1,5	0,6	1,62	143
КЛ210-60	2.1	0,6	2,56	240.2
КЛс90-90	0,9	0,9	0,84	87,4
КЛс120-90	1,2	0,9	1,24	139,4
КЛс150-90	1,5	0,9	1,76	177,8
КЛс120-120	1,2	1,2	1,38	148,6
КЛс150-120	1,5	1,2	1,94	188,6
КЛс210-120	2,1	1,2	2,82	299,2

Key: (1). Mark/brand of channel. (2). Dimensions of channel in m. (3). Concrete composite (in m^3). (4). Steel (in kg)

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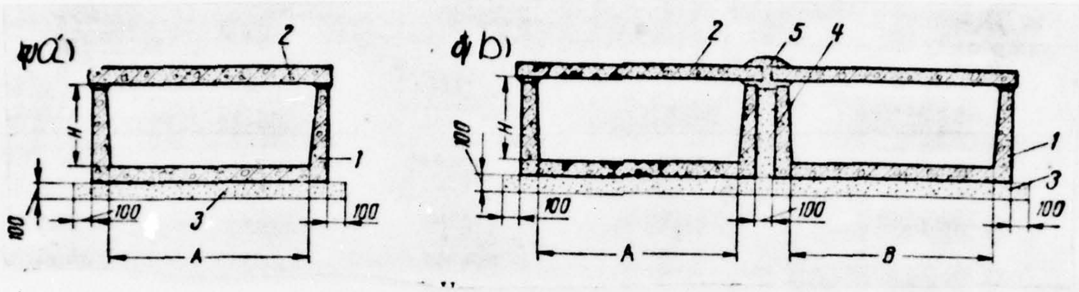

Fig. 15.5. Impassable channels of type KL. a) unicellular; b) bicellular; 1 - chute cell/element; 2 - plate/slab of overlap; 3 - sand training/preparation; 4 - sand; 5 - cement key.

Fig. 15.6. Impassable channels of type KLs. a) unicellular channel; b) bicellular channel; 1 - reinforced-concrete chute cell/element; 2 - double T; 3 - sand training/preparation; 4 - sand; 5 - cement key.

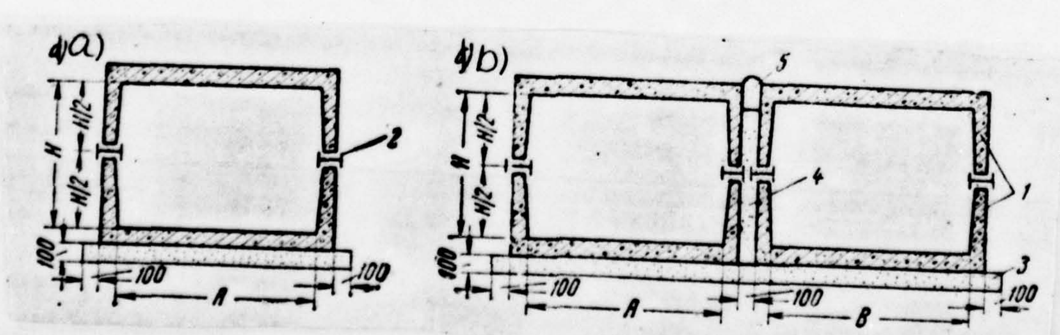

Table 15.5. The overall dimensions of bicellular channels 2KL and 2KLs (see Fig. 15.5b; 15.6b).

(1) Марка канала	(2) Габариты каналов в м		
	А	Б	Н
2КЛ 60-30	0.6	0,6	0,3
2КЛ 60-45	0.6	0,6	0,45
2КЛ 90-45	0,9	0 9	
2КЛ (60+90)—45	0,6	0,9	
2КЛ 60-60	0,6	0,6	0,6
2КЛ 90-60	0,9	0 9	
2КЛ 120—60	1,2	1,2	
2КЛ (60+90)—60	0,6	0,9	
2КЛ (60+120)—60	0,6	1,2	
2КЛ (60+150)—60	0,6	1,5	
2КЛс 90-90	0,9	0,9	0,9
2КЛс 120-90	1,2	1,2	
2КЛс 150-90	1,5	1,5	
2КЛс (90+120)—90	0,9	1,2	
2КЛс (90+150)—90	0,9	1,5	
2КЛс (120+150)—90	1,2	1,5	
2КЛс 120-120	1,2	1 2	1,2
2КЛс 150-120	1,5	1,5	
2КЛс 210-120	2.1	2.1	
2КЛс (120+150)—120	1,2	1,5	
2КЛс (120+210)—120	1,2	2,1	
2КЛс (150+210)—120	1,5	2,1	

Key: (1). Mark/brand of channel. (2). Dimensions of channels in m.

Table 15.6. The consumption of materials on 3 lin. m. of the channels of brands KS and 2KS (see Fig. 15.7).

(1) Марка канала	(2) Габариты каналов в м			(3) Расход бетона в м³		(6) Расход стали в кг
	A	B	H	(4) сборного	(5) монолитного	
КС 90-90	0,9	—		1,44	0,11	158,8
КС 120-90	1,2	—		1,62	0,11	193,4
КС 150-90	1,5	—		1,93	0,11	227,9
КС 210-90	2,1	—	0,9	2,84	0,11	322,5
КС 90-120	0,9	—		1,72	0,09	209,2
КС 120-120	1,2	—		1,9	0,09	243,8
КС 150-120	1,5	—	1,2	2,21	0,09	278,3
КС 210-120	2,1	—		3,12	0,09	372,9
2КС 120-90	1,2	1,2		2,9	0,11	310,5
2КС 150-90	1,5	1,5		3,5	0,11	375,7
2КС 210-90	2,1	2,1		5,34	0,11	599,9
2КС (90+120)—90	0,9	1,2	0,9	2,88	0,11	305,3
2КС (90+150)—90	0,9	1,5		3,03	0,11	317,3
2КС (90+210)—90	0,9	2,1		3,69	0,11	381,8
2КС (120+150)—90	1,2	1,5		3,12	0,11	332,4
2КС (120+210)—90	1,2	2,1		3,78	0,11	396,9
2КС 120-120	1,2	1,2		3,32	0,09	367,8
2КС 150-120	1,5	1,2		3,92	0,09	433
2КС 210-120	2,1	1,2	1,2	5,76	0,09	657,2
2КС (90+120)—120	0,9	1,2		3,3	0,09	362,6
2КС (90+150)—120	0,9	1,5		3,45	0,09	374,6
2КС (90+210)—120	0,9	2,1		4,11	0,09	439,1
2КС (120+150)—120	1,2	1,5		3,54	0,09	389,7
2КС (120+210)—120	1,2	2,1		4,2	0,09	454,2

Key: (1) Mark/brand of channel; (2) Dimensions of channels in m; (3) Consumption of concrete in m^3; (4) composite; (5) monolithic; (6) Consumption of steel in kg.

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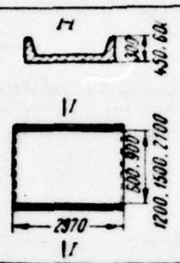
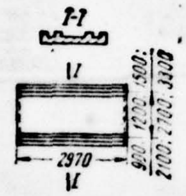
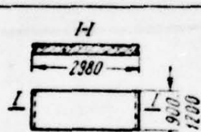
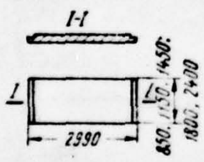
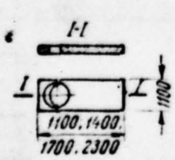
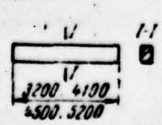
Table 15.7. Nomenclature of composite reinforced-concrete articles for channels and the consumption of materials for one article.

(1) Наименование изделия	(2) Эскиз	(3) Марка изделия	(4) Вес в т	(5) Марка бетона	(6) Расход материалов на 1 изделие (7) бетон в $м^3$	(8) сталь в кг	(9) Лист выпуска 2-й серии
(10) Лотки		Л1	0,73	300	0,29	17,4	1
		Л2	0,88	300	0,35	18,8	2
		Л3	1,07	300	0,43	28,3	3
		Л4	1,05	300	0,42	37,3	4
		Л5	1,25	300	0,5	39,1	5
		Л6	1,55	300	0,62	63,3	6
		Л7	1,72	300	0,69	67,9	7
		Л8	2,2	300	0,88	81,7	8
		Л9	2,42	300	0,97	87,1	9
		Л10	3,52	300	1,41	141,2	10
(11) Плиты днища		ПД-1	1,7	300	0,68	84,3	21
		ПД-2	1,7	300	0,68	78,5	21
		ПД-3	1,92	300	0,77	103,8	22
		ПД-4	1,92	300	0,77	91,5	22
		ПД-5	2,15	300	0,86	116,4	23
		ПД-6	2,15	300	0,86	103,1	23
		ПД-7	3,18	300	1,27	167,9	24
		ПД-8	3,18	300	1,27	136,7	24
		ПД-9	1,5	300	0,6	79	25
		ПД-10	1,5	300	0,6	64,4	25
		ПД-11	1,7	300	0,68	89,7	26
		ПД-12	1,7	300	0,68	77	26
		ПД-13	2,75	300	1,1	158,7	27
		ПД-14	2,75	300	1,1	129,4	27
(12) Плиты стеновые		ПС-1	0,53	300	0,21	27,8	28
		ПС-2	0,88	300	0,35	53	29
		РС-1	1,05	300	0,42	28,9	30
		РС-2	1,4	300	0,56	35,8	31
(13) Плиты перекрытий		П1	0,45	200	0,18	11,8	32
		П2	0,85	200	0,34	18,9	32
		П3	1,08	300	0,43	34	32
		П4	1,63	300	0,65	55,9	32
		П5	2,88	300	1,15	99	32
		П6	1,08	300	0,43	45,7	34
		П7	1,63	300	0,65	73,1	34
		П8	2,88	300	1,15	128	34
(14) Плиты перекрытий с отверстиями		ПО1	0,25	300	0,1	34,4	46
		ПО2	0,4	300	0,16	29,4	47
		ПО3	0,63	300	0,25	34,2	47
		ПО4	1,18	300	0,47	60,6	48
(15) Балки перекрытий		Б1	1	300	0,4	45,9	49
		Б2	1,28	300	0,51	63,2	49
		Б3	1,45	300	0,58	71,4	50
		Б4	1,63	300	0,65	93,8	50

Key: (1). the designation of article. (2). Draft/drawing. (3). the mark/brand of article. (4). Weight in t. (5). Mark/brand of concrete. (6). Consumption of materials for article. (7). concrete in m^3. (8). steel in kg. (9). Plate of the issue of the 2nd series. (10). Tray/chutes. (11). Plate/slabs of bottom. (12). Plate/slabs are wall. (13). Plate/slabs of overlaps. (14). Plate/slabs of overlaps with holes. (15). Floor beams.

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In series IS-01-04 ~~IS - 01,~~ are also developed the working drawings of composite channels for building in areas with the seismicity above 7 points, with settled ground and in the presence of ground water.

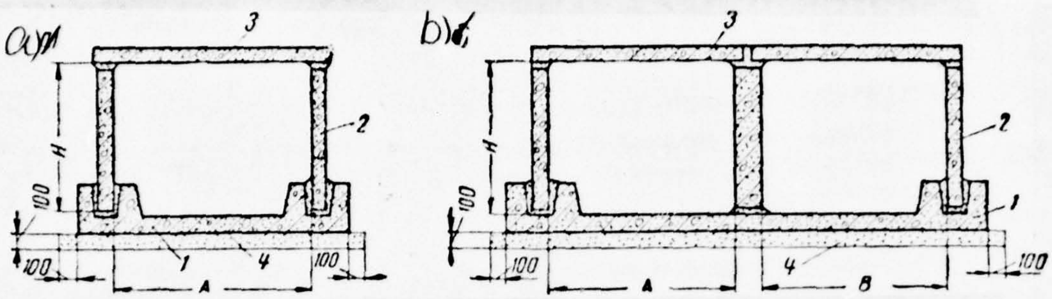
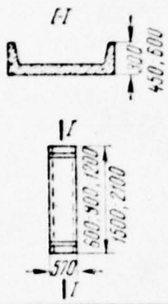
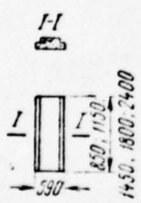


Fig. 15.7. Impassable channels of type KS. a) unicellular; b) bicellular; 1 - reinforced-concrete plate/slab of bottom 2 - reinforced-concrete wall plate/slabs; 3 - plate/slab of overlap; 4 - sand training/preparation.

Table 15.8. Nomenclature of composite reinforced-concrete articles for channels and the consumption of materials for one article (finishing cell/elements.

(1) Наименование изделия	(2) Эскиз	(3) Марка изделия	(4) Вес в т	(5) Марка бетона	(6) Расход материалов на 1 изделие: (7) бетон в $м^3$	(8) сталь в кг	(9) Лист выпуска 2-й серии
(10) Лотки		Л1д	0,15	300	0,06	4,8	11
		Л2д	0,18	300	0,07	5,2	12
		Л3д	0,2	300	0,08	7,5	13
		Л4д	0,2	300	0,08	9,1	14
		Л5д	0,25	300	0,1	9,5	15
		Л6д	0,3	300	0,12	14,3	16
		Л7д	0,43	300	0,13	15,5	17
		Л8д	0,43	300	0,17	20,1	18
		Л9д	0,48	300	0,19	21,6	19
		Л10д	0,68	300	0,27	29,1	20
(11) Плиты стеновые		ПС1д	0,1	300	0,04	6,7	28
		ПС2д	0,18	300	0,07	11,6	29
		РС1д	0,2	300	0,08	8,5	30
		РС2д	0,28	300	0,11	10,3	31
(12) Плиты перекрытий		П1д	0,1	200	0,04	3,5	33
		П2д	0,18	200	0,07	4,8	33
		П3д	0,23	300	0,09	7,9	33
		П4д	0,33	300	0,13	12,3	33
		П5д	0,58	300	0,23	21,7	33
		П6д	0,23	300	0,09	10,2	35
		П7д	0,33	300	0,13	15,6	35
		П8д	0,58	300	0,23	27,5	35

Key: (1). Designation of article. (2). Draft/drawing. (3). Mark/brand of article. (4). Everything in t. (5). Mark/brand of concrete. (6). consumption of materials for 1 article. (7). concrete in m^3. (8). steel in kg. (9). Plate of the issue of the 2nd series. (10). Tray/chutes. (11). Plate/slabs are wall. (12). Plate/slabs of overlaps.

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Tunnels (passage channels).

By GOSSTROY of the USSR is introduced into action the series IS-01-05 "standardized composite reinforced-concrete tunnels" in which are developed working drawings one- and the two-section tunnels, intended for construction in unsettled soils of dry and in the presence ground water with seismicity to 6 points. The width of single-section tunnels is 1.5; 1.8; 2.1; 2.4; 3; 3.6; 4.2 m, height/altitude 2.1; 2.4 and 3 m. Width of two-section tunnels 5.2; 6.4; 7.6 and 8.8 m, height/altitude 2.4 and m.

By institute Mosinzhproyekt are developed reinforced-concrete tunnel- collector/receptacles from composite cell/elements. Collector/receptacle is assembled from the component/links of frame of construction with length 1.8 and 2.4 m. Sections are fulfilled the normal and increased strength. The sections of normal strength are designed for travelling load NK-80 with the sinking of overlap to 2 m, increased - to 4 m the fundamental characteristics of collector/receptacles from frame component/links are given i table 15.9.

Collector/receptacle from the close-ribbed plate/slabs, manufactured with the method of continuous rolled stock on the machine tools of engineer's system N. Ya. Kozlov, is designed to the action of travelling load NK-80 with the sinking of the top of overlap to 2 m. the fundamental characteristics of collector/receptacles from close-ribbed plate/slabs are given in table 15.10.

Collector/receptacle from composite reinforced-concrete blocks is installed of three basic cell/elements: the wall blocks of L-shaped form, flat/plane plate/slabs of bottom and plate/slabs of overlap. The joint between wall blocks and the plate/slabs of bottom is monolithicized.

Collector/receptacles are fulfilled common and ~~those who wer~~ intensified. Common collector/receptacles are designed for travelling load NK-80 with deepening to 2 m, intensified - to 4 m. The basic indices of collector/receptacles from composite reinforced-concrete blocks are given in table 15.11.

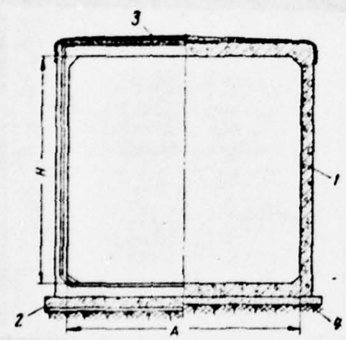

Fig. 15.8. Collector/receptacle from closed blocks on project of Mosinzhproyekt. 1 - reinforced-concrete block; 2 - reinforced-concrete block/backing under joint; 3 - backing isolation/insulation of joint; 4 - sand training/preparation.

Table 15.9. Consumption of materials for 100 running meters of collector/receptacle from the closed blocks on the standard project of Mosinzhproyekt (Fig. 15.8).

(1) Размеры секции в м		(2) Объем железобетона в м³	
A	H	(3) сборного	(4) монолитного
2,1	2,1	133,6	1,4
2,4	2,4	157,6	2,4
2,7	2,7	176,3	2,65

Key: (1). Size/dimensions of section in m. (2). Volume of reinforced concrete in m³. (3). composite. (4). monolithic.

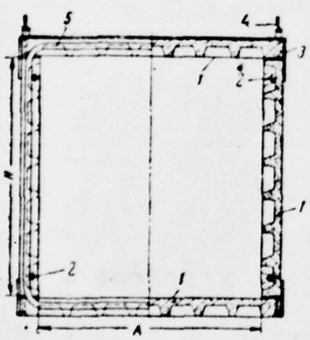

Fig. 15.9. Collector/receptacle of Mosinzhproyekt from composite close-ribbed plate/slabs. 1 - plate/slab; 2 - bolt for the connection of plate/slabs; 3 - backing waterproofing; 4 - inventory loop for the lift of plate/slab; 5 - intersectional packing of steam insulation by section/cut 20 x 40 mm.

Table 15.10. Consumption of materials for of 1 section (3. running m) composite collector/receptacle from close-ribbed plate/slabs on the standard project of Mosinzhproyekt (Fig. 15.9).

(1) Размеры в м		(2) Объем бетона в $м^3$	(3) Вес стали в кг
A	h		
2,1	2,1	3,04	461
2,4	2,4	3,61	558
2,7	3	4,2	774
2,1	2,4	3,24	490
2,4	3	3,99	728

Key: (1). Size/dimensions in m. (2). Volume of concrete in m^3. (3). Weight of steel in kg.

Table 15.11. *Consumption of materials on 100 lin. m of* collector/receptacles from composite reinforced-concrete blocks (Fig. 15.10).

(1) Размер в м		(2) Объем сборного железобетона в $м^3$	(3) Объем монолитного бетона в $м^3$
A	H		
1,7	1,8	103,9	20,6
1,9		110,6	11
2,1		116	11,2
2,3		120,7	11,4
2,5		128	11,7
2,7		133,3	11,9
1,7	2,1	110,5	22
1,9		117,2	11,4
2,1		122,5	11,6
2,3		127,2	11,8
2,5		134,5	12,1
2,7		139,9	12,3
1,9	2,4	123,7	12
2,1		129,1	12,2
2,3		133,8	12,4
2,5		141,1	12,7
2,7		146,4	12.9
1,9	3	141,2	12,9
2,1		146,6	13,1
2,3		151,3	13,3
2,5		158,6	13,6
2,7		163,9	13,8

Note. Depending on the size/dimensions of collector/receptacles, the content of reinforcement bar in

m^3 of the precast reinforced concrete comprises, with the sinking of top to 2 m - 100 - 120 kg, with the sinking of top from 2 to 4 m - 105 - 140 kg.

Key: (1). Size/dimension in m. (2). volume of the precast reinforced concrete in m^3. (3). Volume of monolithic concrete in m^3.

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Supporting structures.

Intermediate saddles in impassable channels are fulfill, in the form of flat/plane rectangular composite reinforced-concrete pillows. The cradles are packed to the hearth of channel in cement mortar.

In the upper part of the cradles, are establish/installed the laying metallic parts, which protrude from concrete to height/altitude to 20 mm and which ensure the unimpeded slip of steel saddles.

The thickness (height/altitude) of the cradles is determined by the value of the minimum clearance between the thermal insulation of pipelines and the sex/floor of channel.

The size/dimensions of pillows in plan/layout and their reinforcement are calculated for strength from the condition of the transmission of load from the tubes through the concrete bottom of channel on ground.

Characteristic of pillows on series IS-01-04 are given in table 15.12.

In the case of accomplishing the protective coating of isolation/insulation of the asbestos-cement plastering on the spot the height/altitude of pillows under pipeline diameter 350 mm and more is recommended the accepting of not less than 140 mm.

In semiaccess channels and passage tunnels a lower se[illegible]es of pipelines also they rest on the pillows, used impassable channels.

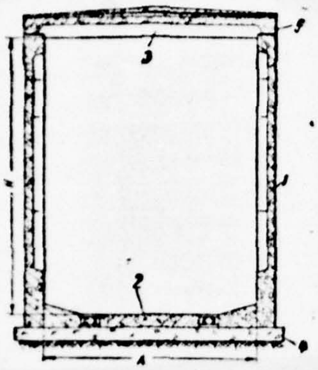


Fig. 15.10.

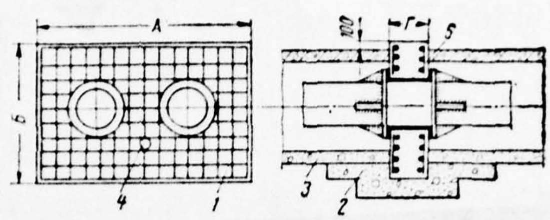
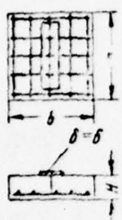


Fig. 15.11.

Fig. 15.10. Collector/receptacle of Mosinzhproyekt from composite reinforced-concrete blocks. 1 - wall L-shaped block; 2 - plate/slab of bottom; 3 - plate/slab of overlap; 4 - concrete training/preparation; 5 - backing waterproofing.

Fig. 15.11. Shield fixed support. 1 - concrete M150; 2 - concrete M75; 3 - bottom of channel; 4 - hole for run off; 5 - asbestos gasket.

Table 15.12. Characteristics of the cradles.

(1) Эскиз	(2) Марка подушки	(3) Размеры подушки в мм: $a \times b$	H	(4) Объем бетона в м³	(5) Марка бетона	(6) Расход стали в кг	(7) Условный диаметр труб в мм	(8) Максимальное расстояние между подушками в м
	ОП1	200×200	90	0,004	800	0,63	25 32 40 50 70	1,7 2 2,5 3 3
	ОП2	200×300		0,005		0,63	80 100 125 150 200	3,5 4 4,5 5 6
	ОП3	400×400		0,015		1,54	250 300	7 8
	ОП4	500×500	140	0,035		2,59	350 400	8 8.5
	ОП5	550×650		0,05		5,68	450	9
							500	10
	ОП6	650×750		0,07		10,08	600	10
	ОП7	750×850		0,09		14,59	700	10
							800	10

Note. The pillows of brands OP-1 and OP-2 are manufactured without reinforcement.

Key: (1). Draft/drawing. (2). Mark/brand of pillow. (3). Size/dimensions of pillow in mm. (4). Volume of concrete in m^3. (5). Mark/brand of concrete. (6). Consumption of steel in kg. (7). Conditional diameter of tubes in mm. (8). Maximum distance between pillows in m.

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The upper tiers of tubes rest either on metallic arms and brackets or on frames.

Fixed supports for pipelines in impassable channels fulfill shield or in the form of the cradles, concreted together with bottom.

Shield fixed supports are vertical reinforced-concrete panels with hole for the pass of tubes. Load from the pipelines through shield supports is transferred on bottom and the wall of channel, but with channel-free packing - to the vertical plane of soil.

Shield supports depending on the load capacity of the hoisting equipment, available on the construction site, fulfill by composite or monolithic. Reinforcement of shield supports, as a rule, double, symmetrical.

for decrease in the temperature effect of tubes on the concrete between tube and concrete of support, is arranged asbestos gasket by thickness 10-30 mm depending on the temperature of heat carrier.

Table 15.13 gives the fundamental characteristics of composite reinforced-concrete shield supports in impassable channels, developed by Mosenergoproyekt [Planning Office of the Moscow Regional Administration of Power System Management] for tubes by diameter to 400 mm and designed for load to 50 t (depending on the diameters of tubes).

The constructions of stationary supports in the form of the pillows, fulfilled together with the lower cell/elements of channels, are developed VGPI Electroheat-plan. The fixed fastening of tubes on them is realize/accomplished by clam supports (Fig. 15.12).

With large axial loads from pipelines, are applied the monolithic supports of different constructions. One Of such supports is given in Fig. 15.13.

Channel-free packing.

VGPI Electroheat-plan is developed the album of the standard working drawings of channel-free packing for two-tube thermal grid/networks by diameter from 50 to 1000 mm for different hydrogeological conditions.

With packing in the dry clay, sand and densely packed soils the isolated/insulated pipelines are packed on sand pillow (table 15.14).

With pipe laying in wet soils or in the zone of ground water is arranged incidental drainage (Fig. 15.15, table 15.15).

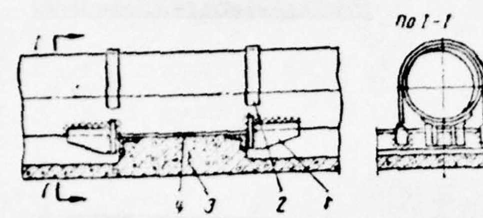

Fig. 15.12. Fundamental solution of fixed fastening of pipelines by clamp supports. 1 - detent; 2 - clamp; 3 - support; 4 - packing of steel plates.

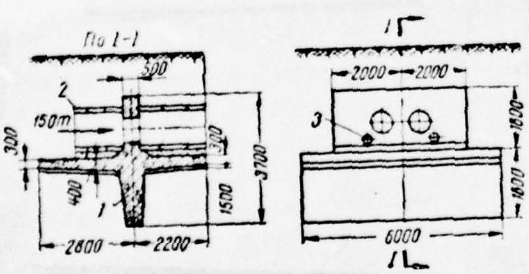

Fig. 15.13. Fixed support from monolithic reinforced concrete. 1 - support; 2 - channel; 3 - drain hole.

[По = On]

Table 15.13. Size/dimensions and the consumption of material for one shield fixed support (Fig. 15.11).

(1) Диаметр трубо-провода в мм	(2) Размеры в мм			(3) Расход материалов	
	А	Б	Г	(4) железо-бетона в $м^3$	(5) бетона в $м^3$
25	1000	700	100	0,07	0,15
32	1100	700	100	0,07	0,15
40	1100	700	100	0,07	0,15
50	1100	700	100	0,07	0,15
80	1400	900	150	0,18	0,24
100	1400	900	150	0,18	0,24
125	1400	900	150	0,18	0,24
150	1400	900	150	0,18	0,24
200	2000	1100	200	0,42	0,58
250	2000	1100	250	0,52	0,58
300	2500	1400	300	1	0,19
350	2500	1400	350	1,12	0,19
400	2500	1400	400	1,27	0,19

Key: (1). Diameter of pipeline in mm. (2). Size/dimensions in mm. (3). Consumption of materials. (4). reinforced concrete in m³. (5). concrete in m³.

Table. 15.14. Basic dimensions of the section/cut of channel-free packing in dry soils (Fig. 15.14).

(1) Тип прокладки	(2) Диаметр изоляции		(5) Основные размеры в мм						
	(3) подающей D_1	(4) обратной D_2	A	l	$Б$	B	$в$	K	h
Б-50	219	99	1150	350	550	600	250	100	280
Б-70	249	118	1150	350	550	600	250	100	280
Б-80	301	131	1150	350	550	600	250	100	280
Б-100	311	160	1250	400	600	650	300	150	310
Б-125	361	185	1350	500	650	700	300	150	310
Б-150	411	211	1350	500	650	700	350	150	410
Б-200	464	271	1500	550	700	800	350	150	430
Б-250	516	325	1600	600	750	850	350	150	460
Б-300	567	377	1700	650	800	900	400	200	480
Б-350	612	429	1850	700	850	1000	400	200	510
Б-400	666	478	2000	800	950	1050	450	250	530
Б-450	712	530	2200	900	1050	1150	450	250	560
Б-500	756	581	2300	1000	1100	1200	450	250	580
Б-600	854	682	3100	1300	1500	1600	450	250	630
Б-700	952	772	3300	1400	1600	1700	450	250	680
Б-800	1050	872	3500	1500	1700	1800	500	300	730
Б-900	1152	972	3700	1600	1800	1900	500	300	780
Б-1000	1250	1072	3900	1700	1900	2000	500	300	830

Key: (1). Type of packing. (2). Diameter of isolation/insulation. (3). feeding. (4). reverse/inverse. (5) basic dimensions in mm.

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In the filled, peaty and other soft dry ground in the base of sand pillow, are provided for the additional packing of composite reinforced-concrete plate/slabs (Fig. 15.16) or the replacement of soft ground by the condensed sand filling by depth not less than 500 mm.

With packing in wet soft ground additionally to measures mentioned above is arranged incidental drainage (Fig. 15.17). The volumes of work on foundation for channel-free packing are given in table 15.16.

Fixed supports with channel-free packing for loads to 100 t are fulfilled, as a rule, in the form of the vertical reinforced-concrete right-angled panels.

With large loads are arranged the T-supports which consist of vertical panel and base plate. For an increase in the stability of support to shift/shear the base plate is made with one or two teeth. For the facilitation of the cell/elements of t-shaped support bottom and vertical panel it should be connected by buttressses.

During the arrangement/position of support in the camera/chamber the support is performed in the form of the steel framework/body, sealed into sex/floor and overlap of the camera/chamber.

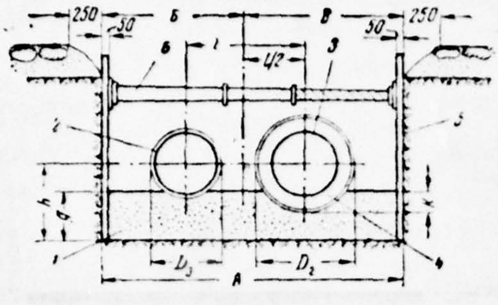

Fig. 15.14.

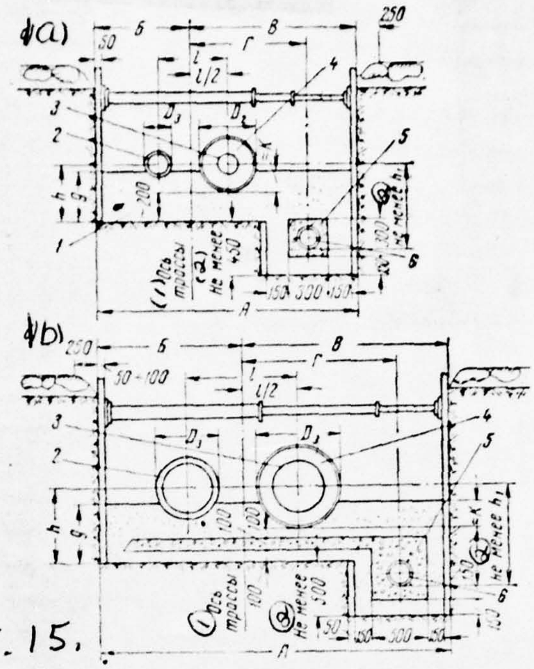

Fig. 15.15.

Fig. 15.14. Section/cut of channel-free packing of thermal grid/networks of types B-50 is B-1000 in dry soils. 1 - sand coarse-grained; 2 - return line; 3 - direct/straight pipeline; 4 - shell from autoclave cellular concrete; 5 - reinforcement of trenches with boards; 6 - inventory space

Fig. 15.15. Section/cut of channel-free packing of thermal grid/networks in wet soils (size/dimension on table 15.21). a) for the types of packing B-50 - B-250; b) for the types of packing B-300 - B-1000; 1 - sand coarse-grained; 2 - return line; 3 - direct/straight pipeline; 4 - isolation/insulation of autoclave cellular concrete; 5 - gravel; 6 - asbestos cement tube.

Key: (1). Axle/axis of route. (2). it is not less.

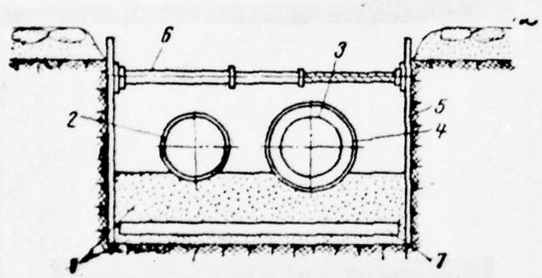

Fig. 15.16. Section/cut of channel-free packing of types B-50 is B-1000 in soft dry ground. 1 - sand coarse-grained; 2 - reverse/inverse heating main; 3 - straight line of hot water pipe; 4 - isolation/insulation from autoclave concrete; 5 - strengthening trenches with boards; 6 - inventory spacer; 7 - composite reinforced-concrete plate/slab.

Table the 15.15. Basic size/dimensions of the section/cut of channel-free packing in wet soils (Fig. 15.15).

(1) Тип прокладки	(2) Диаметр изоляции		(5) Основные размеры в мм								
	(3) подающей D_1	(4) обратной D_2	A	l	$Б$	$В$	$Г$	g	K	h	h_1
Б-50	249	99	1600	350	550	1050	700	350	150	330	530
Б-70	249	118	1600	350	550	1050	700	350	150	330	530
Б-80	301	131	1600	350	550	1050	700	350	150	330	530
Б-100	311	160	1700	400	600	1100	750	350	150	360	550
Б-125	361	185	1800	500	650	1150	800	350	150	360	550
Б-150	411	211	1850	500	650	1200	850	350	150	410	600
Б-200	464	271	1950	550	700	1250	900	350	150	430	630
Б-250	516	325	2100	600	750	1350	1000	350	150	460	650
Б-300	567	377	2300	650	800	1500	1050	500	200	580	780
Б-350	612	429	2400	700	850	1550	1100	500	200	610	810
Б-400	666	478	2550	800	950	1600	1150	550	250	630	830
Б-450	712	530	2750	900	1050	1700	1250	550	250	660	860
Б-500	756	581	2850	1000	1100	1750	1300	550	250	680	880
Б-600	854	682	3500	1300	1500	2000	1500	550	250	730	930
Б-700	952	772	3700	1400	1600	2100	1600	550	250	780	980
Б-800	1050	872	3900	1500	1700	2200	1700	600	300	830	1030
Б-900	1152	972	4100	1600	1800	2300	1800	600	300	880	1080
Б-1000	1250	1072	4300	1700	1900	2400	1900	600	300	930	1130

Key: (1). Type of packing. (2). Diameter of isolation/insulation. (3). feeding. (4). reverse/inverse.

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Table 15.16. Volumes of work on foundation under pipelines with channel-free packing (on 1 km of route).

(1) Тип основания	(2) Характеристика грунта	(3) Наименование	(4) Единица измерения	(5) Условный проход труб																	
				50	70	80	100	125	150	200	250	300	350	400	450	500	600	700	800	900	1000
I	(6) Сухой	Песчаное основание (7)	м³	252	250	249	331	360	422	470	500	574	628	728	803	848	1168	1270	1436	1518	1598
II	(9) Сухой слабый	Песчаная подготовка (8)	.	56	58	58	63	68	68	75	80	85	93	100	110	115	165	165	175	185	195
		Песчаное основание (7)	.	252	250	249	331	360	422	470	500	574	628	728	803	818	1168	1270	1436	1518	1598
		Сборные железобетонные плиты (10)	.	115	115	115	125	135	135	150	160	255	277	300	330	345	465	496	525	555	565
III	(12A) Мокрый	Песчаное основание (7)	.	314	312	311	340	375	384	418	465	494	528	615	693	729	1003	1060	1236	1318	1398
		Дренирующий горизонтальный гравийный слой (11)	.	—	—	—	—	—	—	—	—	150	160	175	195	205	270	290	310	330	350
		Песчаная обсыпка дренажа (12)	.	320	320	320	320	320	320	320	320	585	585	625	625	625	625	628	665	665	665
		Гравийная обсыпка дренажа (13)	.	79	79	79	79	79	79	79	79	352	352	352	352	352	337	337	337	337	337
		Дренажные трубы (14)	м	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
		Дренажные колодцы (15)	шт.	25	25	25	25	25	20	20	20	20	20	20	20	20	20	20	20	20	20
IV	.	Песчаная подготовка (8)	м³	48	48	48	53		6	65	73	73	78	85	95	100	128	143	153	163	173
		Песчаное основание (7)	.	314	312	311	340	375	388	418	465	494	528	615	693	729	1003	1060	1236	1318	1398
		Дренирующий горизонтальный гравийный слой (11)	.	—	—	—	—	—	—	—	—	150	160	175	195	205	270	290	310	330	350
		Песчаная обсыпка дренажа (12)	.	320	320	320	320	320	320	320	320	585	585	625	625	625	625	625	665	665	665
		Гравийная обсыпка дренажа (13)	.	79	79	79	79	79	79	79	79	352	352	352	352	352	337	337	337	337	337
		Дренажные трубы (14)	м	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
		Дренажные колодцы (15)	шт.	25	25	25	25	25	20	20	20	20	20	20	20	20	20	20	20	20	20
		Сборные железобетонные плиты (10)	м³	95	95	95	105	115	120	130	145	218	233	255	285	300	398	428	458	488	518

Notes. 1. For tubes with pass 50-250 mm, drain pipes are accepted by diameter 100 mm, for tubes with pass, it is more than 250 mm, by diameter 150-200 mm. 2. On linear sections drainage wells are fulfilled by diameter 1 m and by depth to 3 m.

Key: (1). Type of base. (2). Characteristic of soil. (3). Designation. (4). Unit of measurement. (5). The internal diameter of tubes. (6). Dry. (7). Sand base. (8). Sand training/preparation. (9). Dry weak. (10). Composite reinforced-concrete plate/slabs. (11). Drain/venting horizontal gravel layer. (12). Sand sprinkling of drainage. (12A). Wet (13). Gravel sprinkling of drainage. (14). Drain pipes. (15). Drainage wells. (16). pcs.

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For providing the independent upsetting of reinforced-concrete supports and pipelines, and also for decrease in the thermal effect of pipelines on concrete on the section of the passage of tubes in concrete pipelines should be turned with asbestos cord. The independent upsetting of tubes and steel framework/bodies is achieved

artificial changing the quantity of steel plates, placed under pipeline during installation.

The fundamental characteristics of the shield supports, designed for the perception of axial load from tubes to 90 t, are given in table 15.17.

Incidental drainage.

Drainage devices lay along pipelines along one or both sides. In the first case the drainages are called one-way in the second - bilateral. One-way drainages lay from the inflow of ground water.

For providing the stable decrease in the ground water at depth not less than 200 mm from the bottom of isolation/insulation the sinking of the top of drain pipes is accepted not less than 300 mm from the bottom of channel, but with channel-free packing - from the lower surface of isolation/insulation of pipelines. The construction of drainages depends on the filtration factor of soils.

With the filtration factor of more than 20 m/day the drainage is arranged in the form of drain pipes without the filtering sprinkling. In this case, in coarse-grained sands (d = 0.5-1 mm) apply only ceramic drain pipes (GOST 8411-57), in gravelly soils with the diameter of particles 4-10 mm and more can be applied any drain pipes.

In soils with filtration factor to 0.6 m/day and the small inflow of ground water (in essence from "perched water table") longitudinal drainage is arranged in the form of the filtering sprinkling of channel and water-collecting receivers.

in soils with the filtration factor of more than 0.5 m/day, the drainage is realize/accomplished in the form of the drain pipe, laid within the filtering sprinkling. Drainages are packed with the front rakes not less than 0.002 in clay soils and not less than 0.003 - in sand.

Tubes by the diameter of less 125 mm as drainage are not applied.

In the places of the replacement of the diameters of

drain pipes on rotations and with jump/drops in the levels of tubes are establish/installed channelization type wells.

On direct/straight sections the distance between manhole on drainage is accepted:

for tubes by diameter 125 mm. it is not more than 40 m.

for tubes 150-300 mm. it is not more than 50 m.

for tubes is more than 300 mm. it is not more than 75.

Material for drain pipes is selected in accordance with data given in table 15.18.

As drainage sprinkling are applied coarse-grained sand, average gravel, and also crushed stone of the ejected rocks and neutral sand with filtration factor are not less than 20 m/day.

For the drainage of compensator niches from basic drainage, are arranged separate branches. The construction branches accepts similar basic drainage. In the places of branches, are established/installed the manholes.

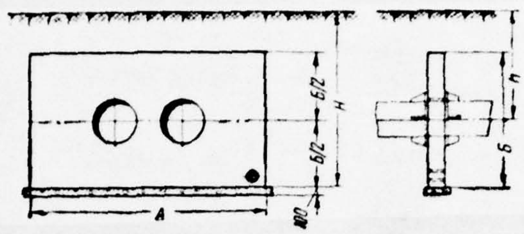

Fig. 15.18.

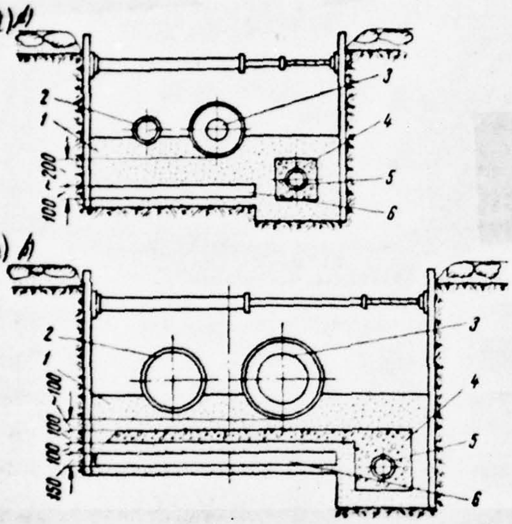

Fig. 15.17.

Fig. 15.17. Section/cut of channel-free packing in wet soft ground. a) for the types of packing B-50 - B-250; b) for the types of packing B-300 - B-1000; 1 - sand coarse-grained; 2 - return line; 3 - direct/straight pipeline; 4 - gravel; 5 - asbestos-cement drain pipe; 6 - composite reinforced-concrete plate/slab.

Fig. 15.18. Shield fixed support with channel-free parking.

Table 15.17. Basic characteristics of shield fixed supports for channel-free pipe laying.

(1) Условный диаметр труб в мм D_y	(2) Расчетное усилие в т	(3) Размеры щита в м			(4) Глубина заложения в м		(7) Расход материалов на один щит		
							(8) бетона марки 200 в м³	(9) арматурной стали в кг	
		A	Б	C	(5) оси труб	(6) щита H		Ст. 3	25Г2С
50—125	8 11 14	2	1	0,15	0,9 1,1 1,3	1,4 1,6 1,8	0,3	4	40
150—250	15 20 25	2,5	1,5	0,2	1 1,2 1,4	1,75 1,95 2,15	0,73	8	80
300—500	35 40 50	3,5	2	0,25	1,2 1,4 1,6	2,2 2,4 2,6	1,67	2	296
600—1000	70 80 90	4,5	2,5	0,35	1,45 1,65 1,85	2,7 2,9 3,1	3,19	6	525

Note. Holes in panel are accepted more than outside diameters of the tubes: on 40 mm - for tubes with conditional diameter 50-150 mm; on 60 mm - by diameter 200-350 mm, on 80 mm - by diameter 400-1000 mm.

Key: (1). Conditional diameter of tubes in mm. (2).

Calculated effort/force in t. (3). Size/dimensions of panel in m. (4). Depth of laying in m. (5). the axle/axis of tubes. (6). panel. (7). Consumption of materials for one panel. (8). concrete of brand 200 in m^3. (9). reinforcement bar in kg.

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With the pass of drainages in shield supports, leave the holes for the passage of drain pipes. The diameter of hole is accepted upon 200 mm more than outside diameter tubes.

On the section where drain pipes are passed through the camera/chambers, the tubes they perform from metal. In this case in the places of the pass of tubes through walls, are establish/installed passage gaskets.

VGPI Electroheat-plan in standard album are developed five primary constructions of the section/cuts of drainages

Figures 15.20 shows the section/cut of a drainage of type I, designed to application/use in soils with the

filtration factor of more than 10 m/day for the draining of channels of any type.

The section/cut of the drainage of types II and IIa (Fig. 15.21a) are applied for the channels of any type in filtration factor of less 0.5 m/day, if the gradient/draft of channel in the direction does not coincide with run-off to the place of runoff.

Table 15.18. Table of the application/use of drain pipes (Fig. 15.19 a-e).

(1) Наименование	ГОСТ	(2) Условия применения	(3) Способ приема дренажных вод
(4) Керамические дренажные трубы	8411—57	(5) При заложении дренажей до 4 м	(6) Через стыки труб
(7) Керамические канализационные трубы	286—54	(5) При заложении дренажей до 6 м	(8) Через незаделанную часть
(9) Керамические кислотоупорные трубы	585—41	(10) При заглублении дренажей до 6 м и pH менее 5	(11) То же
(12) Бетонные безнапорные трубы	6482—53	(13) При глубоких дренажах; при карбонатной жесткости не менее 3 градусов, при pH не менее 7; при допустимых нормах углекислой, сульфатной и магнезиальной агрессивности, определяемой по Н114-54. При pH равной 6, сульфатах 1—4 г/л, газах 10—50 мг/л все поверхности труб покрывают специальной антикоррозийной обмазкой	
(14) Асбестоцементные трубы	1839—48	(15) При слабокислых водах (pH=5—6)	(16) Через отверстия в стенках труб
(17) Стальные трубы	3262—55; 8732—58	(18) Только для напорных трубопроводов и под железнодорожными путями, а также при пропуске через камеры и на конечных участках сброса дренажа в открытые водоемы	—
(19) Чугунные трубы	5525—50	(20) Для напорных трубопроводов и под железнодорожными путями	—

Key: (1). Designation. (2). application/use condition. (3). Method of the intake of drainage water. (4). Ceramic drain pipes. (5). With the laying of drainages to 4 m. (6). Through the joints of tubes. (7). Ceramic sewers. (8). Through the unsealed part. (9). Ceramic acid-resistant tube: (10). With the sinking of drainages to 6 m and pH it is less than 5. (11). The same. (12). Concrete nonramming tubes. (13). With deep drainages; with carbonate hardness is not less than 3 degrees, with pH it is not less than 7; with the permissible norms of the carbonate, sulfate and magnesium aggressiveness, determined on N114-54. With pH equal to 6, sulfates 1-4 g/l, gases 10-50 mg/l, all surfaces of tubes cover/coat with special anticorrosive greasing. (14). Asbestos cement tubes. (15). With weakly acid water. (16). Through holes in walls of tubes. (17). Steel tubes. (18). Only for delivery conduits and under railway lines, and also with the passage through the camera/chambers and on finite segments of runoff of drainage into the open basins. (19). Cast-iron pipes. (20). For pressure pipelines and under railroads.

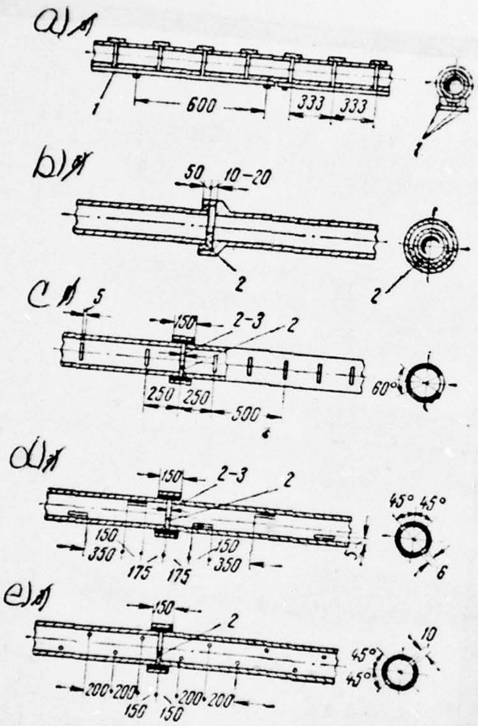
a)
600
333
333
1
b)
50
10-20
2
c)
5
150
2-3
2
250
250
500
60°
d)
150
2-3
2
150
350
175
175
150
350
45°
45°
6
e)
150
2
200
200
150
150
200
200
45°
45°
10

Fig. 15.19.

Fig. 15-19. Drain pipes. a) ceramic drainage; b) ceramic channelization and concrete nonartesian flared; c) asbestos cement nonartesian with vertical holes; d) the same, with horizontal holes; e) the same, with round holes; 1 - bars 50 x 50 mm; 2 - framing by asbestos-cement solution.

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A section/cut of type III (Fig. 15.21b) are applied for the channels of any type in filtration factor of less 0.5 m/day, if the gradient/draft of the bottom of channel corresponds to the direction of run off to jettisoning.

The drainage section/cut of types IV and v (Fig. 15.21c, d) is applied for passage and semiaccess channels in the filtration factor of soil to 10 m/day. With the filtration factor of more than 10 m/day, the sprinkling around channel in section/cuts IV and v is not made.

For the channel-free packing of thermal grid/networks any type, are developed the drainage section/cuts VI, VIa and VII. The drainages of types VI (unilateral) and VIa (bilateral) (Fig. 15.22a) are designed to application/use in soils with the filtration factor of more than 0.5 m/day,

and also in soils with the filtration factor of less 0.5 m/day, if the gradient/draft of heating mains does not coincide with the direction of the jettisoning of drainage water.

During the agreement of the gradient/draft of the pipelines of thermal grid/networks with the direction of the jettisoning of drainage water in soils with the filtration factor of less 0.5 m/day, apply a drainage section/cut of the type VII (Fig. 15.22b).

The basic dimensions of the filtering sprinkling for the drainages of types I - VII are given in table 15.19

Volume 1 lin. m. of the filtering sprinkling is given ~~and~~ in table 15.20.

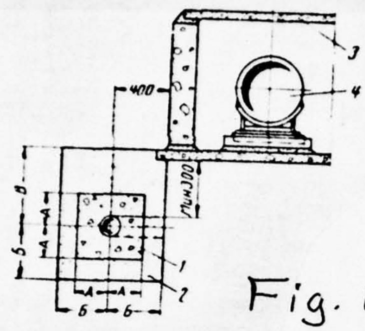

Fig. 15.20.

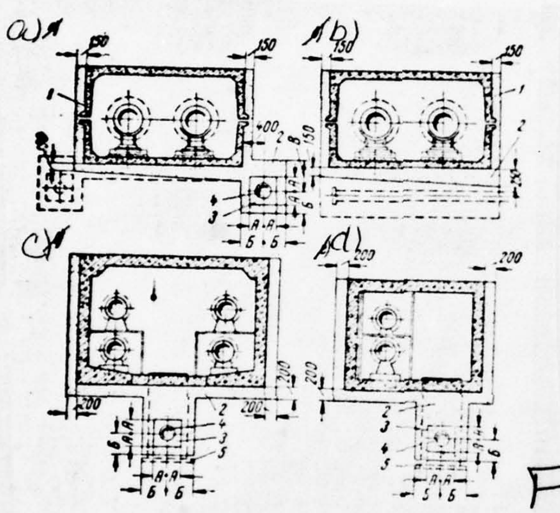

Fig. 15.21.

Fig. 15.20. Section/cut drain Ja, type I. 1 - gravel, average; 2 - sand coarse-grained; 3 - channel; 4 - pipeline.

Fig. 15.21. Section/cut of drainages. a) types II and IIa (bilateral); b) type III; c - type IV; d) type V; 1 - channel; 2 - sand coarse-grained; 3 - gravel, average; 4 drain pipe; 5 - drainage well.

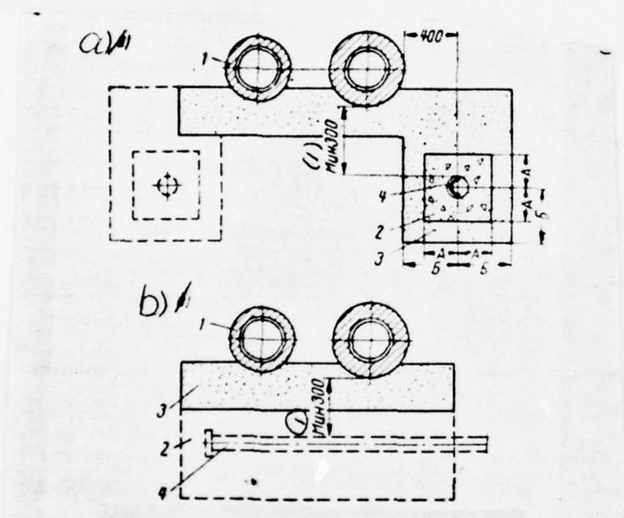

Fig. 15.22. Section/cut of drainages. a) type VI and VIa (bilateral); b) type VII. 1 - pipeline; 2 - gravel average; 3 - sand large; 4 - drain pipe.

Key: (1). Min.

Table 15.19. The size/dimensions of the filtering sprinkling of the drainages of types of I-VII (see Fig. 15.20-15.22).

(1) Обозначение	(2) Трубы канализационные керамические асбоцементные и бетонные				(3) Трубы керамические дренажные
	$D_y = 125 \div 150$	$D_y = 200$	$D_y = 250$	$D_y = 300$	
А	250	300	350	400	--
Б	400	450	500	550	250
В, (4) не менее	375	400	525	450	375

Key: (1). Designation. (2). Are rough channelization ceramic asbestos-cement and concrete. (3). Tubes ceramic drainage. (4). it is not less.

Table 15.20. Volume 1 lin. m. of the filtering sprinkling of a drainage section/cut of type I.

(1) Материал обсыпки	(2) Объем фильтрующей обсыпки при условном диаметре дренажной трубы в мм				
	125	150	200	250	300
(3) Гравий средний сортированный	0,23	0,222	0,315	0,422	0,544
(4) Песок крупнозернистый .	0,583	0,61	0,584	0,585	0,57

Note. The volumes of filtering filling are calculated for a one-way drainage with the difference of the marks of the bottom of channel and tray/chute of drain pipes 70 cm.

Key: (1). Material of sprinkling. (2). Volume of the filtering sprinkling with the conditional diameter of drain pipe in mm. (3). Gravel average sorted. (4). Sand is coarse-grained.

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15.3. Above-ground laying.

Above-ground pipe laying is performed: on the low separate supports; on the high separate supports (masts); pier with span structure in the form of drive/girders, farm/trusses or suspension constructions.

With packing on low supports, the distance inside between the heat insulation and the earth's surface is accepted not less than 0.5 m with the width of the group of tubes more than 1.5 m and not less than 0.35 m with the width of the group of tubes to 1.5 m.

The high separate supports confronting are subdivided into rigid, flexible and those who are rocking (Fig. 15.23a, b, c).

Rigid supports are separate columns or the frames, rigidly connected with foundation. Flexible towers are the steel struts, rigidly sealed into foundation. The top of flexible towers hinged is connected with pipeline and during the temperature elongation of pipeline is moved together with tube. The displacement of the top occurs because of the elastic bending of strut.

The rocking high supports consist of the steel or reinforced-concrete strut, hinged connected with foundation. The top of struts hinged is connected with the resting pipeline and because of the rotation of strut around lower hinge joint can freely be moved a horizontal direction during the displacement of pipelines from temperature chang

With large extent pier they divide by the expansion joints into the temperature blocks, which consist:

of inner bearings, receiving vertical and horizontal loads from span structures and load from wind on support itself; one anchor pole, the receiving load from span structures, horizontal and vertical loads from pipelines and side loads from wind.

The maximum permissible distances between the expansion joints are determined from SNIP II-V.1-62 and SNIP II-V.3-62.

For the purpose of decrease in the horizontal column loads, the compensators on pipelines, as a rule, are installed in the expansion joints between the blocks of the bridge, and in each temperature block is provided for anchor pole for the fixed fastening of pipelines.

In this case the reaction of the friction of saddles is absorbed by span structure, and to anchor pole is transferred only the reaction of the elasticity of flexible compensators. The schematic of the arrangement of compensators and fixed supports is given in Fig. 15.24.

Large-diameter pipelines, as as rule, rest on the supports of pier, while the pipelines of small diameters to supports and to the traverses, packed for the span structures of pier.

With pipe laying in separate supports the anchor pole

are establish/installed only in the assemblies of the fixed fastening of pipelines. Piers with suspension span structure consist of masts, the bracings and traverse, on which rest the pipelines. Sometimes is applied the circuit during bracings with the suspension/mounting of tubes to transverse traverses.

With the number of suspensions in flight/span, more than two dip of carrier are determined according to the equation

$$y = 4fx\left(\frac{l - x}{l^2}\right), \qquad (15.5)$$

where y is a value of dip at point at a distance of x from the origin of coordinates (Fig. 15.25);

f - the value of the greatest dip in the middle of flight/span;

x - distance from the origin of coordinates to the assembly y of which is determined dip;

l - the effective span.

For maintenanacae of fittings in the assemblies of tubes

with packing on high supports and on piers are set up area/sites with enclosure/protections and permanent ladders. With the device of area/sites at height/altitude more than 5 m of the earth/ground on staircases make enclosure/protections.

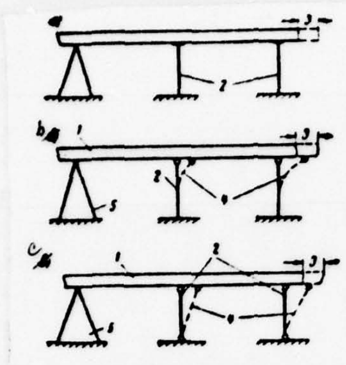

Fig. 15.23. Forms of inner bearings. a is the rigid support; b is flexible tower; c is a double-hinged (rocking) support; 1 - pipeline; 2 - inner bearings; 3 - thermal strain; 4 - position of inner bearings after thermal strain; 5 - anchor pole.

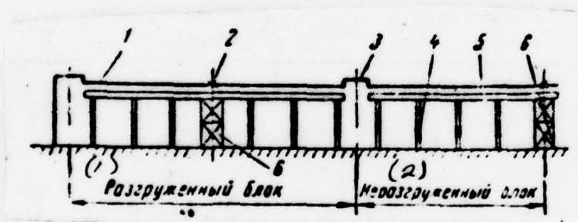

Fig. 15.24. Recommended circuit of arrangement of compensators and fixed fastenings of pipelines. 1 - pipeline; 2 - fixed support; 3 - compensator; 4 - intermediate mast; 5 - span structure; 6 - stayed mast.

Key: (1). Floating block. (2). Undischarged block.

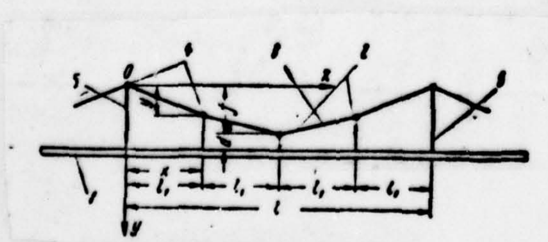

Fig. 15.25.

Fig. 15.25. Pattern of span structure of guy construction. 1 - pipeline; 2 - suspension; 3 - guy; 4 - crosspiece; - pylon.

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Loads on above-ground constructions.

With the above-ground packing of thermal grid/networks, the structures are designed for dead loads, snows, ice-covered surface, the actions of wind, load on the maintenance platforms and load from pipelines and equipment on them.

Loads from snow and wind on the unit of area of structures are accepted according to SNIP for the concrete/specific/actual area of building. Loads from ice-covered surface are accepted according to the data of meteorological stations. Loads from snow and ice-covered surface on pipelines are not considered. Loads on maintenance platforms on piers are accepted equal to 250 kg/m².

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DESIGNER'S HANDBOOK - INSTALLING THERMAL PIPE-LINE SYSTEMS. PAR--ETC(U)

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Loads from pipelines see in chapter 11.

Design loads on the traverses of inner bearings under pipelines are composed of dead weight, vertical and horizontal loads from pipelines and horizontal loads from wind. Loads from pipelines are accepted in the form of concentrated loads at the points of the support of tubes.

Vertical design load on the crosshead of inner bearing from pipeline is determined from the formula

$$P = nql\ m, \qquad (15.6)$$

where q is weight of one pipeline with heat carrier and insulation construction in t/m;

l - the distance between saddles in m;

n - load factor for weight load from pipelines is taken as equal to 1.2 (0.8).

During the determination of total vertical loads from steam lines, one of the steam lines, that creates unfavorable load on any cell/element of support or pier,

considered with the filling with water, and the others - without water.

Horizontal design load on the crosshead of movable support is equal to

$$H = nfql \; t, \qquad (15.7)$$

where f is the coefficient of friction, taken for roller bearings, 0.1; for sliding bases 0.3; for strap supports $f = \Delta l/S$;

Δl - the maximum value of the temperature displacement of pipeline in the place of support in m;

S - the length of suspension in m;

n - load factor 1.1 (0.9).

Calculated horizontal load on crosshead from the action of wind on pipeline is determined from the formula

$$H_{в} = nCD_{н} q_0' l \text{ kg} \qquad (15.8)$$

where n is a load factor to load due to wind, equal to 1.2;

l - the distance between the nearest points of support in m;

C - the aerodynamic coefficient, equal to 1.4;

q_0 - standard velocity head of wind in kg/m^2;

D_n - the outside diameter of a cover layer of thermal insulation construction in m.

With packing of two and more the pipelines, arrange/located in one tier and which rest on one to traverse, wind pressure is considered from one pipeline with the greatest diameter of a cover layer of thermal insulation construction.

With pipe laying in several tiers wind pressure are considered from one greatest pipeline in each tier.

Total horizontal load on the crosshead of movable support with multitube packing is defined as sum of horizontal loads from each tube, multiplied on the

coefficient of the asynchrony of the action of forces of friction.

Traverses at the fixed attachment points of pipelines are designed for the action of dead weight, vertical and horizontal loads from tube wire/conductors and horizontal loads from wind.

Vertical load from pipelines is defined just as for the crossheads of inner bearings from formula (15.6).

Total horizontal loads from pipelines on the crosshead of anchor pole with multitube packing are determined:

from the forces of elastic deformation with flexible compensators and during auto/self-compensation and from the unbalanced forces of internal pressure on the sum of forces from each pipeline;

from forces of friction of movable supports and of gasket compensators - on the sum of forces from each pipeline with the coefficient, which considers the asynchro-nousness of the action of these forces:

(1)	при двух системах трубопроводов	1
(2).	трех	0,67
(3).	четырех и более системах трубопроводов	0,5

Key: (1). in two manifolds. (2). with three. (3). in four and more manifolds.

One Manifold are considered feeding and return lines of water thermal grid/networks either the steam lines, which transport from one source vapor of one parameter, or condensate lines.

During sum determination of forces of friction for three and larger quantity of manifolds with the application/use of diversity factors 0.67 or 0.5, it is necessary to make check calculations also for cases with smaller quantity of manifolds and to accept as calculated larger of the obtained values.

Load factor for horizontal loads from pipeline is accepted $k_n = 1,1$ (0,9).

Horizontal load from wind is defined just as for the crosshead of inner bearing from formula (15.8).

Design loads on the rigid span structures of piers are

composed of dead weight, the vertical loads, which are transferred by traverses, horizontal column loads from force of friction of the saddles, transverse loads from wind on span structure, loads from the ice-covered surface, snow, the maintenance platforms and of external temperature effect on pier.

The greatest longitudinal horizontal load on span structure from forces of friction of saddles appears in the nearest to anchor pole flight/span and is considered on section from the axle/axis of the temperature breakage of the pier d of the anchor attachment of pipelines by the formula

$$H = nfqL \; t, \qquad (15.9)$$

where q is weight 1 lin. m. of the pipeline of all laid pipelines in t/m;

L - the length of section from the axle/axis of the rigid fixing of pipelines of pier up to the axle/axis of temperature of break in m;

f - the coefficient of the friction of supports;

n - load factor, equal to 1.1.

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The columns of the rigid and rocking separate struts are designed for the action of dead weight, loads, transferred by traverses, and the action of wind on column.

The columns of flexible separate inner bearings are designed for the action of dead weight, the action of wind for column, the action of the vertical and transverse loads, transferred by traverses, and the elastic horizontal sag of the top of column to the extent of the maximum temperature movement of the pipeline, hinged connected with the top of column.

The supports (column) of piers are designed for dead loads, loads from the crosshead, which rests on column, the loads, transferred by span structures, and loads due to wind on column.

Constructions of the separate supports.

The low supports, assembled of two flat/plane reinforced-concrete frames and the flat/plane plate/slab, are shown in Fig. 15.26. Supports are designed for the roller and sliding support and the fixed fastening of tubes.

The smallest height/altitude of inner bearings above the earth's surface is 500 mm, fixed, i.e., 650 mm. The overall height of supports on route is constant. Depending on relief, the sinking of supports oscillates from 1.8 to 1 m. With sinking less than 1.8 m around supports is arranged local ground the embankment, preventing the freezing of soil under the support.

VGPI Electroheat-plan is developed the project of low supports according to the type of "rocking" foundations.

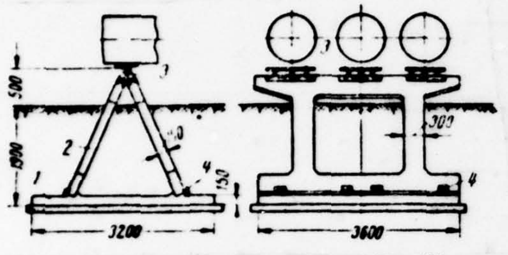

FIG 15.26

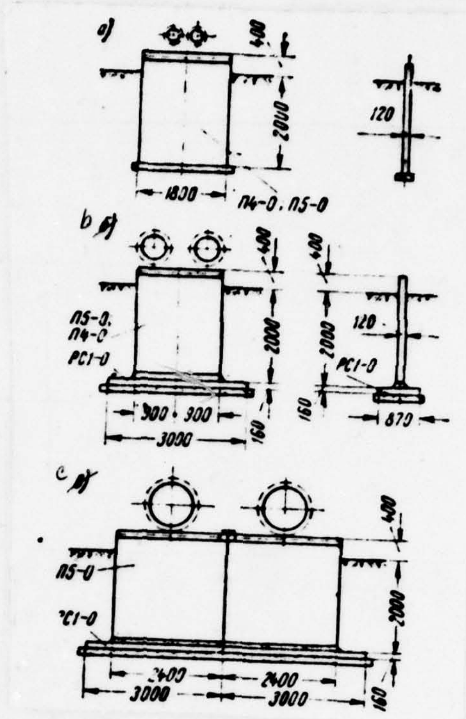

FIG. 15.27

Fig. 15.26. Composite low support. 1 - base plate; 2 - frame; 3 - supporting/reference metallic stands for the support of pipelines; 4 - steel cover plate (during welding).

Fig. 15.27. "rocking" supports - foundations under pipeline:

a - OPV-1, OPV-2; b - OPV-3; OPV-4; c - OPV-5.

Table 15.21. Indices of pivoted bearings under pipelines.

(1) Тип опоры	(2) Диаметр труб при двухтрубной прокладке в мм	(3) Марка элементов	(4) Количество элементов в шт.	(5) Вес элемента в т	(6) Марка бетона	(7) Расход бетона на опору в м³	(8) Расход стали на опору в кг	(9) Нормативная нагрузка в т		
								(10) вдоль оси труб	(11) боковая	(12) вертикальная
ОПВ-1	До 200	П4-О	1	1,3	300	0,52	139,1	2	0,6	2
ОПВ-2	250-300	П5-О	1	2,3	300	0,92	192,5	3,5	1,5	5
ОПВ-3	350-450	РС1-О П4-О	1 1	1,05 1,3	300 300	0,94	198,2	2,6	2,6	9
ОПВ-4	500-700	РС1-О П5-О	1 1	1,05 2,3	300 300	1,34	251,6	5	5	15
ОПВ-5	800-1000	РС1-О П5-О	2 2	1,05 2,3	300 300	2,68	503,2	10	10	30

Note. Cell/elements P4-0, P5-0 and RS1-0 are manufactured respectively in the forms of cell/elements P4, P5 and RS1 on series IS-01-04.

Key: (1). Type of support. (2). Diameter of tubes with two-tube packing in mm. (3). Mark/brand of cell/elements. (4). Quantity of cell/elements in pcs. (5). Weight of cell/element in t. (6). Mark/brand of concrete. (7). Consumption of concrete for support in m³. (8). Consumption of steel for support in kg. (9). Standard load in t. (10). along the axle/axis of tubes. (11). side. (12). vertical.

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Pivoted bearing (Fig. 15.27a, b, c) consists of the flat/plane reinforced-concrete vertical panel, establish/installed on cement mortar to flat/plane base plate. In the upper part of the panel for the support of tubes, there are laying parts.

The height/altitude of the support above planning is accepted minimum, sinking is determined by the depth of freezing and by calculation for the perception of horizontal load the width of panel, as a rule, it is determined by the structural/design arrangement of pipelines. The indices of pivoted bearings are given in table 15.21.

Pile low supports are applied with soft ground and they consist of composite piles and gratings.

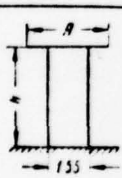
Size/dimensions of piles and their quantity in support are determined depending on the value of vertical and horizontal loads.

Fixed (anchor) low supports for large axial loads, as a rule, are made from monolithic reinforced concrete.

The device of teeth, inclined bottoms and ground

surcharge weight provide the stability of support to shift/shear with the minimum volume of reinforced concrete. Low fixed support under large horizontal loads is shown in Fig. 1528.

Table 15.22. Overall schematics of the separate supports under pipelines.

(1) Тип опоры	(2) Схема	(3) Размеры в м		(4) Нормативная суммарная вертикальная нагрузка на опору в т	(5) Примечания
		A	H		
I		2,4; 3; 4,4; 6	0,4	5—20	
		1,2; 2,4	5,4; 6,6	5	(6) Размер H дан в чистоте между уровнем земли и верхом колонны
II		1,9	5,4; 6,6; 7,8	10—40	
III		3; 4,2; 4,8; 6	5,4; 6,6; 7,8	10—60	(7) Размер H дан в чистоте между уровнем земли и верхней гранью траверсы

Key: (1). Type of support. (2). Circuit. (3). Size/dimensions in m. (4). Standard total vertical load on support in t. (5). Notes. (6). Size/dimension H is given in purity/finish between the ground level and the top of

column. (7). Size/dimension H is given in purity/finish between the ground level and face side of crosshead.

Table 15.23. Indices to 1 crosshead of separate supports under pipelines (Fig. 15.29).

(1) Сечение траверсы в мм	(2) Марка	(3) Длина в м	(4) Расчетные нагрузки от трубопроводов в т/м				(5) Объем бетона в м³	(6) Вес стали в кг
			P_1	P_2	P_3	P_4		
	TOI-1	2,4	13	7	—	—	0,3	42
	TOI-2	3	10,4	5,6	—	—	0,38	55
	TOI-3	4,2	7,4	4	—	—	0,53	73
	TOI-4	6	5,2	2,8	—	—	0,75	104
	TOI-5	2,4	13	7	3,6	1,9	0,3	88
	TOI-6	2,4	13	7	6,9	3,7	0,3	148
	TOI-7	3	20,8	11,3	4,8	2,6	0,38	98
	TOI-8	3	15,6	8,4	8,1	4,4	0,38	171
	TOI-9	4,2	7,4	4	2,1	1,1	0,53	138
	TOI-10	4,2	5,6	3	4,7	2,6	0,53	251
	TOI-11	6	3,9	2,1	1,2	0,7	0,75	225
	TOI-12	6	1,3	0,7	2,2	1,2	0,75	297
	TOI-13	6	5,2	2,8	1,7	0,9	0,75	306
	TOIII-1	3	31,2	16,8	7,2	3,9	0,38	142
	TOIII-2	4,2	22,4	12	5,1	2,8	0,53	225
	TOIII-3	4,8	4,9	2,6	1,5	0,8	0,6	148
	TOIII-4	4,8	2,5	1,3	3	1,6	0,6	256

Note: 1. - In tabular loads are taken into account load factors: for vertical loads from pipelines 1, 2; for horizontal - 1.1.

2. Cell/elements TO1-1; 2; 3; 4 are designed as beam on elastic base.

Key: (1). Section/cut of crosshead in mm. (2). Mark/brand. (3). Length in m. (4). Design loads from pipelines in t/m (5). Volume of concrete in m³. (6). All steels in kg.

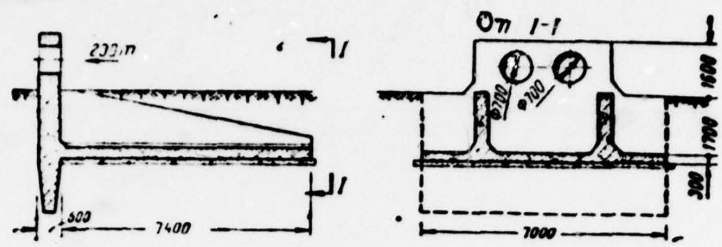


Fig. 15.28. Fixed support from monolithic reinforced concrete with low pipe laying.

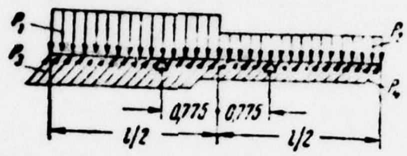


Fig. 15.29. Load diagram on crosshead.

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The best structural/design arrangement of teeth it is considered: with one tooth - in the middle of bottom or of forward edge, with two - at the distances of one fourth from the front/leading and rear edges of bottom [1].

FOOTNOTE [1]. Front/leading is considered the edge of support in the direction of the action of load. ENDFOOTNOTE.

Teeth should be made trapezoidal cross-section and to concrete the entire support.

For the more uniform adjoining of supporting/reference parts on pipelines to concrete the upper part of the supports it is expedient to concrete after the installation of the section of tubes and victuals to them of the bearing disks.

In order to decrease the thermal effect of hot tubes on concrete, sections of tubes in supports before concreting it should be turnmed asbestos by plates or cord by thickness to 40 mm. The wrapper of tubes by a layer of asbestos is especially necessary with the device of support under steam lines. In supports under pipelines with the temperature of medium to 100°C asbestos layer it can be replaced by one layer of the roofing whose designation/purpose is to prevent cohesion/coupling the walls of tubes with concrete of support.

In a series of GOSSTROY of the USSR IS-01-06, are

developed single-stage supports by clearance between the ground level and the top of crosshead from 0.4 to 7.8 m.

Depending on size/dimensions, design loads and constructions of support, they are divided into three types I, II, III (table 15.22). Columns and traverses are made in the standardized plankings of the cell/elements of industrial buildings, foundations - on individual projects.

Each type supports are divided into intermediate, anchor intermediate and anchor end.

On nonbuckling soils an intermediate low support of type I is fulfilled in the form of the cross bar, packed by wide side on ballast pillow. The base of ballast pill is sunk to the height/altitude of a vegetable layer.

Low supports of type I, designed for their landing in swelling soils, are fulfilled in the form of the cross bar, welded to two short struts, that forms part of foundation and performed by individual project.

High supports are made either in the form of T-shape columns or in the form traverse, packed to columns. Anchor

poles under large loads are fulfilled metallic. The type of crossheads and columns on ~~artificial satellite~~ IS-01-06 is selected depending on load and dimensions (table 15.23-15.25).

In a series of GOSSTROY of the USSR IS-01-~~07~~, are developed the working drawings of composite reinforced-concrete two-level piers with clearance from the mark of the earth/ground to the bottom of the drive/girder of lower tier 5.4; 6 and 6.6 m, for vertical loads 3.5; 5; 4 t/m.

By the institute Goskhimproyekt by assignment of GOSSTROY of the USSR are developed the working drawings of the high separate supports for tubing in two tiers. Supports are designed for vertical load from 5 to 40 t.

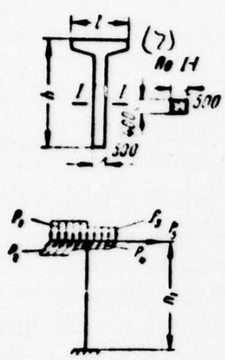
15.4. Transitions of the thermal grid/networks through obstructions.

Transition mode in each specific case is determined by local conditions - by the possibility of the stop of

motion to the time of building and repair during operation by the presence of underground and above-grade communication in area of transition, by the method of the compensation for the thermal elongations of pipelines on section, by the material status of construction organization, by architectural considerations and others.

On the sections of underground crossings, the pipelines lay in the impassable, semiaccess or passage channels which as a rule, are erected in a open manner (Fig. 15.30a). With the impossibility of the production of the work in an open manner instead of channels, are applied shells of steel or reinforced-concrete tubes by diameter 800 mm and it is above, which lay by the method of extrusion. The length of extrusion usually does not exceed 60-80 m.

Table 15.24. Indices to 1 column of the separate supports under pipelines.

(1) Эскиз и схема нагрузок	(2) Марка	(3) Размеры в м			(4) Расчетные нагрузки от трубопроводов и ветра в т/м; т					(5) Объем бетона в $м^3$	(6) Вес стали в кг
		l	h	h_1	P_1	P_2	P_3	P_4	P_5		
	КОП-1	1,2			6,5	3,5	1,2	0,6	1,1	1,4	99
	КОП-2	1,2	6,2	5,2	6,5	3,5	2,4	1,3	2,2	1,4	177
	КОП-8	2,4			3,3	1,8	0,6	0,3	0,6	1,6	125
	КОП-9	2,4			3,3	1,8	1,2	0,6	1,7	1,6	202
	КОП-12	1,2			6,5	3,5	1,2	0,6	1,1	1,64	154
	КОП-13	1,2			6,5	3,5	2,4	1,3	2,2	1,64	267
	КОП-19	2,4	7,4	6,4	3,3	1,8	0,6	0,3	0,6	1,84	179
	КОП-20	2,4			3,3	1,8	1,2	0,6	1,7	1,84	293
	КОП-22	1,2			6,5	3,5	1,2	0,6	1,1	1,88	213
	КОП-23	1,2	8,6	7,6	6,5	3,5	2,4	1,3	2,2	1,88	316
	КОП-29	2,4			3,3	1,8	0,6	0,3	0,6	2,08	238
	КОП-30	2,4			3,3	1,8	1,2	0,6	1,7	2,08	362

Key: (1). Draft/drawing and load diagram. (2). Mark/brand. (3). Size/dimensions in m. (4). Design loads from pipelines and wind in t/m; t. (5). Volume of concrete in m³. (6). Weight of steel in kg. (7). On.

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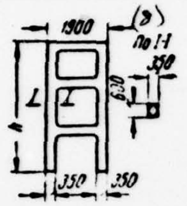
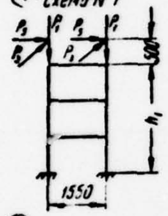
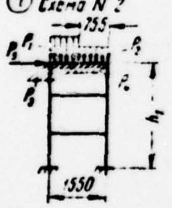
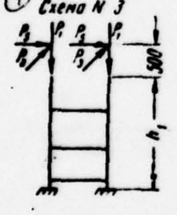
With pass through the high mounds of automobile or railroads, the pipelines lay either in shells, stacked by the method of puncture or extrusion or in tunnels, raised by shield method (Fig. 15.30b). The transitions through the highways of local importance (in certain cases) are

fulfilled because of the elevation of the marks of road with tubing under road in impassable channels or round shells without the vertical fracture of the axle/axes of the tubes of thermal grid/networks (Fig. 15.30c). The height/altitude of such passages usually is within the limits 1-2 m.

Above-grade transition (Fig. 15.30d), the representing vertical U-shaped compensator, is applied in essence during the intersection of iron and highways with the pipelines, which make it possible to overlap the flight/spans, sufficient for the passage of transport.

On both sides of transition, the pipelines are fastened in fixed supports. Under the vertical sections of tubes, are arranged sliding type step bearings. Horizontal loads from wind are absorbed by pipeline itself and through the wide step bearing and the fixed fastening are transferred to fixed supports.

Table 15.25. Indicators to 1 column of the separate supports under pipelines.

(1) Эскиз колонн и схемы нагрузок	(2) Марка колонн	(3) Размеры в м		(4) Номер схемы нагрузок	(5) Расчетные нагрузки от трубопроводов и ветра в т/м, т					(6) Объем бетона в м³	(7) Вес стали в кг
		h	h_1		P_1	P_2	P_3	P_4	P_5		
	КОП-3 КОП-5 КОП-10	5,9	4,7	1	2 3,9 11,8	— — —	2 3,5 2,6	— — —	2,35 4,6 9,3	3,35	408 665 848
	КОП-14 КОП-16 КОП-8	7,1	5,9	1	2 15,6 11,7	— — —	2 2,5 2,7	— — —	2,55 8,25 9,3	3,85	389 [illegible]69 1001
(9) Схема N 1 	КОП-24 КОП-26 КОП-31	8,3	7,1	1	2 3,9 11,7	— — —	2,7 3,6 2,6	— — —	2,35 4,5 9,3	4,64	548 993 1484
	КОП-4 КОП-6 КОП-11	6,4	5,2	2	8,2 16,4 34	4,4 8,9 17,7	2,3 4,6 9	1,2 2,4 4,9	3,1 4,2 5,2	3,55	342 413 653
	КОП-15 КОП-17 КОП-21	7,6	6,4	2	8,2 16,4 33	4,4 8,9 17,8	2,3 4,5 9	1,2 2,4 4,8	3,1 4,2 4,9	4,06	418 552 901
(9) Схема N 2 	КОП-25 КОП-27	8,8	7,6	2	8,2 16,4	4,4 8,9	2,3 4,5	1,2 2,4	3,1 4,2	4,85	493 801
	КОП-7 КОП-18 КОП-28	5,9 7,1 8,3	4,7 5,9 7,1	3	4,5	—	3,9*	—	6,1	3,35 3,85 4,64	879 1189 1379
	КОШ-1 КОШ-2 КОШ-3	5,9	4,7	3	9 18 36	— — —	2,2 3,9 8,2	— — —	1,7 2,6 3,5	3,35	318 477 799
(9) Схема N 3 	КОШ-4 КОШ-5 КОШ-6 КОШ-7 КОШ-9 КОШ-10	7,1	5,9	3	6 9 9 12 18 24	— — — — — —	1,1 2,2 2,8 2,8 3,9 5,5	— — — — — —	1,4 1,6 2 2 2,7 2,9	3,85	324 401 587 548 671 847
	КОШ-11 КОШ-12 КОШ-13 КОШ-14	8,3	7,1	3	6 9 18 24	— — — —	1,1 2,8 3,9 5,5	— — — —	1,4 2 2,7 3,2	4,64	421 730 888 1107

* При работе колонны в составе неподвижной опоры.

Note. Columns are manufactured in the planking of the

columns of series KE-01-52.

Key: (1). Draft/drawing of columns and of load diagrams. (2). Mark/brand of columns. (3). Size/dimensions in m. (4). Number load diagram. (5). Design loads from pipelines and wind in t/m, t. (6). Volume of concrete in m^3. (7). Weight of steel in kg. (8). On. (9). Circuit.

FOOTNOTE [1]. In the work of column in the composition of fixed support. ENDFOOTNOTE.

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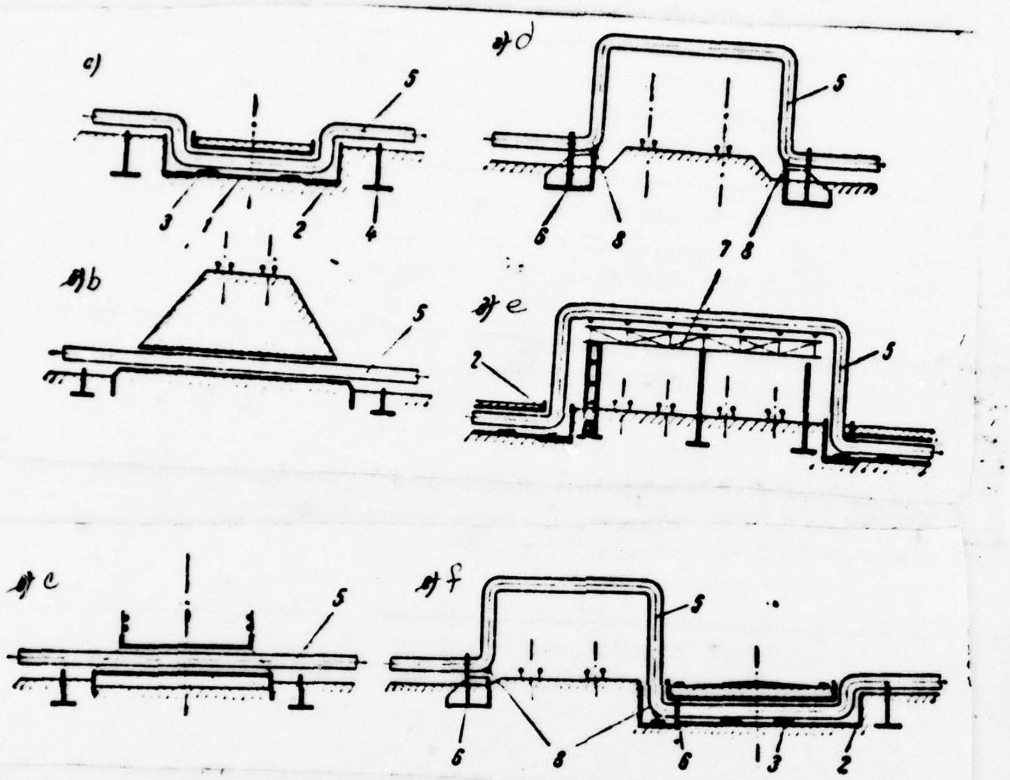

Fig. 15.30. Forms of intersections of roads by thermal networks. a, b, c are underground; d, e - above-grade; f - combined: 1 - channel or shell of tube; 2 - camera/chamber; 3 - cradle; 4 - low intermediate support; - pipeline; 6 - fixed support; 7 - pier; 8 - step bearing.

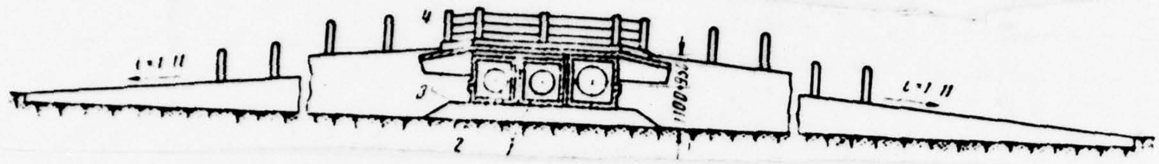

Fig. 15.31. Passage through thermal grid/networks. 1 - pipelines; 2 - channel; 3 - gravel layer; 4 - reinforced-concrete apron.

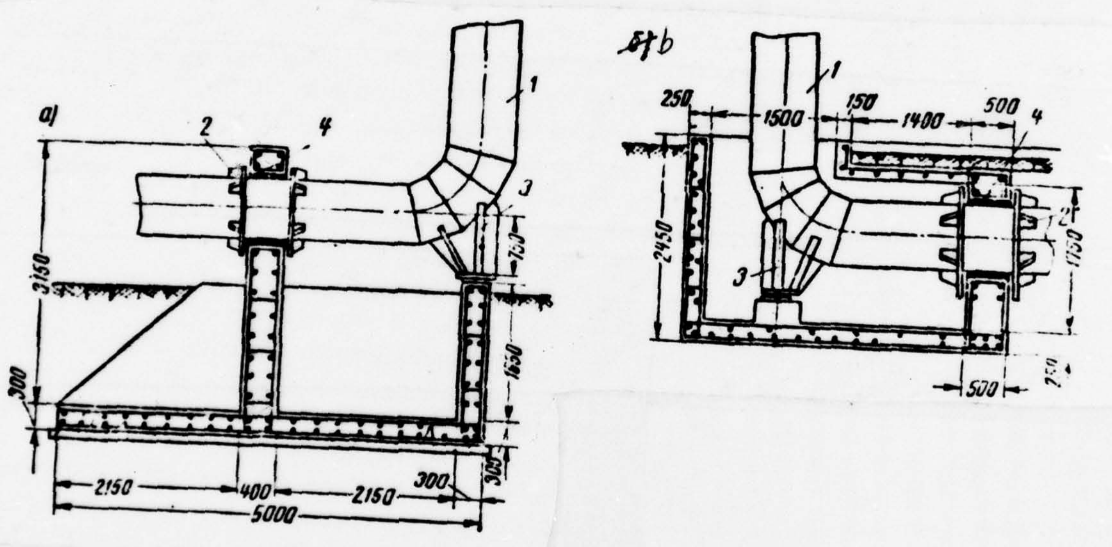

Fig. 15.32. Assemblies of support of U-shaped transitions. - with above-grade packing; b - with underground packing; - pipeline; 2 - fixed shield support; 3 - step bearing; - asbestos gasket.

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With the laying of pipe of small diameter, and also in large flight/span, when the bearing capacity of pipeline is insufficient, are applied above-grade transitions on the separate high supports or on piers (Fig. 15.30e).

During the intersection of the station railway lines of pier under pipelines, frequently they combine with footbridges. In separate cases during the intersection of the in parallel going iron and highways, proves to be advisable the device of the combined transition (Fig. 15.30f), through railway lines - above the earth/ground, through the highway - underground.

The construction of transition by the heating mains through the highways of local importance is shown in Fig. to 15.31.

The assemblies of the support of vertical U-shaped transitions are given in Fig. 15.32.

With intersection of the water obstacles for the passing of thermal grid/networks, as a rule, are utilized the highway bridges. Pipelines rest on the structural cell/elements of bridge under transient part ~~or~~ either pavements or are hung to them. With packing on the foot bridges, the pipelines place under the flooring of bridge (Fig. 15.33).

By VGPI Electroheat-plan is developed the suspension construction of the transition across the river by flight/span 180 m (Fig. 15.34). On the transition are laid two heating mains by diameter on 500 mm, one steam line by diameter 500 mm and one condensate piping by diameter 150 mm. Transition consists of four lift wires by diameter every 70 mm, two wind cables by the diameter 40 mm, of two steel coastal pylons, which rest on concrete foundations.

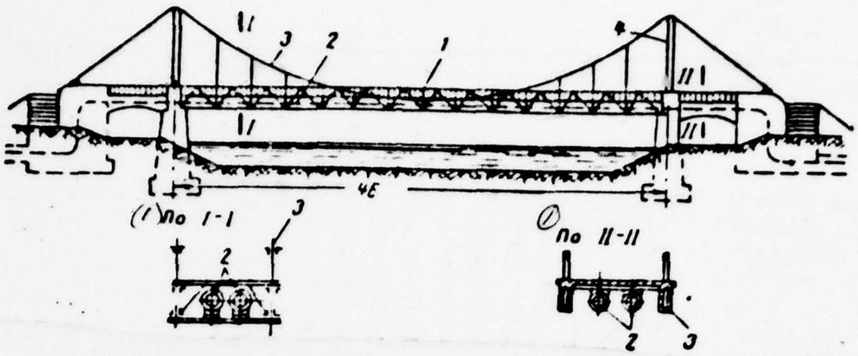

Fig. 15.33. Suspended foot bridge for thermoficated main line. 1 - farm/truss of rigidity; 2 - pipeline; 3 - steel cable; 4 - pylon.

Key: (1). On.

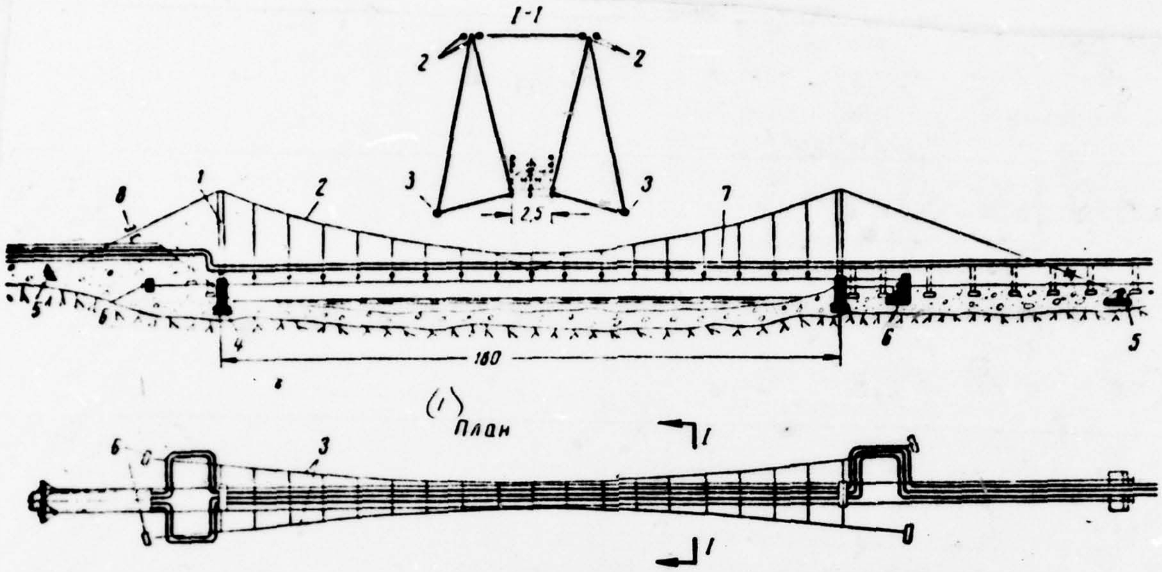

Fig. 15.34. Transition of suspension construction. 1 - pylon; 2 - lift wires; 3 - wind cables; 4 - foundation of pylon; 5 - anchor pole of the lift wires; 6 - anchor poles of wind cables; 7 - pipelines; 8 - tightener.

Key: (1). Plan/layout.

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The ends of the carrying and wind cables are attached in

coastal anchor poles. Near anchor poles on cables, are provided for the tighteners.

On the complex project of Mosenergoproyekt, State Institute for the Planning, Research and Testing of Steel Structures and Bridges and administration of the underwater-technological work, it is constructed and started to operation to 1950 inverted siphons through the Moscow River (Fig. 15.35). It has wall thickness 12-16 mm, intensified through each 3 m by heel rings. Bore of inverted siphon 2.5 m.

In the middle of river, the inverted siphon is sealed into the concrete array, intended for its attachment from axial displacement. To the surface of inverted siphon plotted anticorrosive coating.

For preventing the floating the inverted siphon is overloaded by cast iron semirings. In inverted siphon are laid two steam lines by diameter on 400 mm, two pipelines of water grid/network on 500 mm and two condensate pipings by diameter on 150 mm.

On the project of VGPI Electroheat-plan in Sverdlovsk

is constructed four-arch transition of the two-funnelled heating system through river Iset'. Flight/span of each arc on 37.5 m, the arrow/pointer of lift of approximately 8 m, the diameter of tubes 400 mm.

15.5. Calculations of the special constructions of thermal grid/networks.

Determination of the stresses in soil under foundation level of supports.

With the centrally loaded foundation the medium stresses in soil under horizontal bottom are determined from the formula

$$\sigma = \frac{P_{н}}{F} < R_{гр}\ т/м^2, \qquad (15.10)$$

where $P_{н}$ is a sum of vertical standard loads, including dead weight and the weight of soil, of t;

F - the area of foundation level in m2;

$R_{гр}$ - the calculated resistance of soil at the depth

of the laying of foundation level in t/m².

During joint action on the foundation of vertical forces and torque/moment in one direction of stress under bottom, they are checked using the formula

$$\sigma_{\substack{\text{макс}\\ \text{мин}}} = \frac{P_н}{F} \pm \frac{M_a}{W_a} < 1{,}2R_{гр}\ т/м^2. \quad (15.11)$$

where M_a is torque/moment from all standard loads of the relatively neutral axle/axis of bottom, effective in parallel to side a, in tm;

W_a - the moment of resistance of bottom in the direction of the action of torque/moment M_a in m³.

If $\frac{P}{F} > \frac{M_a}{W_a}$ the diagram of stresses has the form of trapezoid. If $\frac{P_н}{F} = \frac{M_a}{W_a}$ diagram/curve has the form of triangle. When $\frac{P_н}{F} < \frac{M_a}{W_a}$ the diagram of stresses it is obtained ambiguous. When the vertical anchoring of the tail section of the foundation is absent, will be observed the breakaway of the part of the bottom of base. Taking into account the breakaway of the part of the bottom, the greatest stresses under rectangular foundation are equal to

$$\sigma_{\text{макс}} = \frac{4P_н}{3b\,(a - 2e)} < 1{,}2R_{гр}\ т/м^2 \quad (15.12)$$

or

$$\sigma_{\text{макс}} = \frac{2P_н}{3bk} < 1{,}2R_{гр} \ т/м^2, \qquad (15.13)$$

where a and b - width and the length of foundation in m;

e - an eccentricity of load, equal to M/N, in m;

k - distance from the center of gravity of triangular stress diagram of up to the forward edge of bottom in m (Fig. 15.36).

Under the effect of torque/moment in one direction, the breakaway zone of bottom from the complete area of foundation is allowed not more than 33o/o.

In the case of the load of bottom with torque/moments of in two directions the edge stresses under bottom are determined from the formula

$$\sigma_{\substack{\text{макс}\\ \text{мин}}} = \frac{P_н}{F} \pm \frac{M_a}{W_a} \pm \frac{M_b}{W_b} < 1{,}2R_{гр} \ т/м^2. \qquad (15\text{-}14)$$

where M_b is torque/moment from design loads in the direction of side b in tm;

W_b - the moment of resistance of bottom in the direction of the action of torque/moment in m^3.

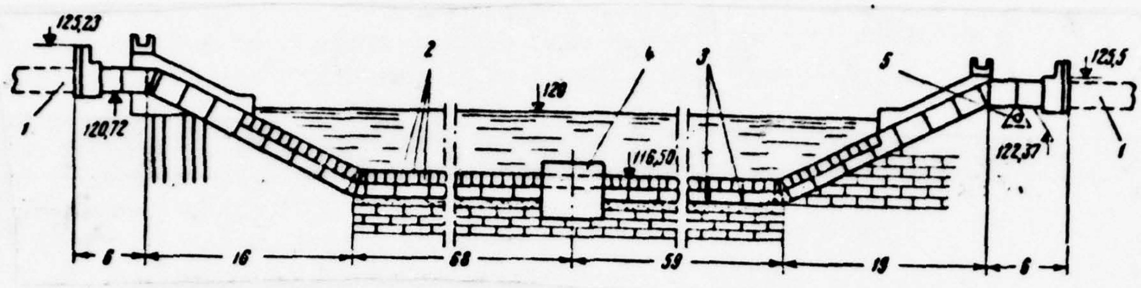

Fig. 15.35. schematic longitudinal section of inverted siphon. 1 - reinforced-concrete tunnel; 2 - cast iron overloaded semirings; 3 - stiffening rib; 4 - concrete fixed support; 5 - roller bearing.

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Under the effect of torque/moments in two directions, the breakaway of bottom in each direction is allow/assumed not more than 20o/o of the complete area of foundation.

When the size/dimensions of bottom are dictated only by stresses, bottom it should be made rectangular form, with long side in the direction of the action of torque capacity.

Inclined bottoms (Fig. 15.37) are arranged in fixed supports, receiving large horizontal loads, and are intended for an increase in the stability of supports against shift/shear.

For calculation are determined the sums of vertical $(P_н)$ and horizontal loads $(H_н)$, the centers of their application/appendix and the torque/moments of these loads of the relatively neutral axle/axis of bottom.

The edge stresses, perpendicular to bottom, are determined from the formula

$$\sigma_{\substack{макс \\ мин}} = \frac{P_н \cos\alpha + H_н \sin\alpha}{F} \pm \pm \frac{M_\alpha}{W_\alpha} \leqslant 1{,}2R_{гр}\ т/м^2. \quad (15.15)$$

where $P_н$ is a sum of all vertical loads, including the weight of soil on the edges of foundation, of t;

$H_н$ - a sum of all horizontal loads of t;

α is angle of the slope of footing to horizontal in deg;

F - the area of sloped bottom F = ab in m^2;

M_a - a sum of the moments of all forces relative to neutral axle/axis of bottom (point 0) tm;

W_a - a moment of resistance of bottom in the direction of torque/moment M_a in m^3.

For the rectangular bottom

$$W_a = \frac{a^2 b}{6} \text{ м}^3, \qquad (15.16)$$

where a and b are length and the width of inclined bottom in m;

$$M_a = H_н m - P_н n .$$

where m and n are distances from the neutral axle/axis of bottom to the force lines $H_н$ and $P_н$.

With the considerable slope/inclinations of bottom ($\alpha >$ 30°), the greatest edge stresses $\sigma_{макс}$ must not exceed stresses σ_n (Fig. 15.38), specific by the formula

$$\sigma_n = (\sigma_{\zeta} + \gamma h) M_0 \ T/м^2, \qquad (15.17)$$

where

$$M_0 = \frac{1 + \sin\varphi \cos\zeta}{1 + \sin\varphi} e^{(\pi - 2\alpha + \zeta) \operatorname{tg} \varphi}, \qquad (15.18)$$

where

$$\zeta = \psi + \arcsin \frac{\sin\psi}{\sin\varphi} \text{ deg};$$

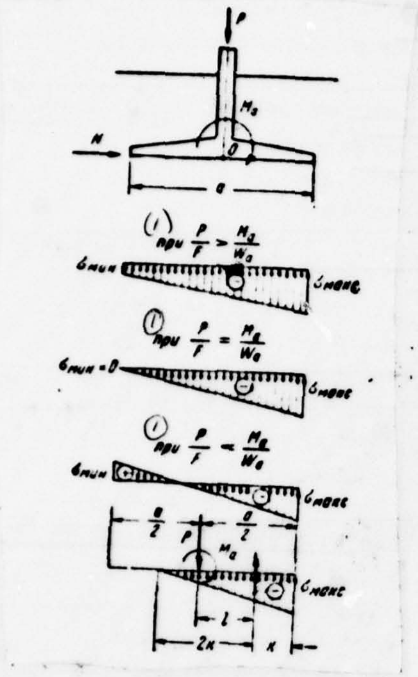

FIG. 15.36

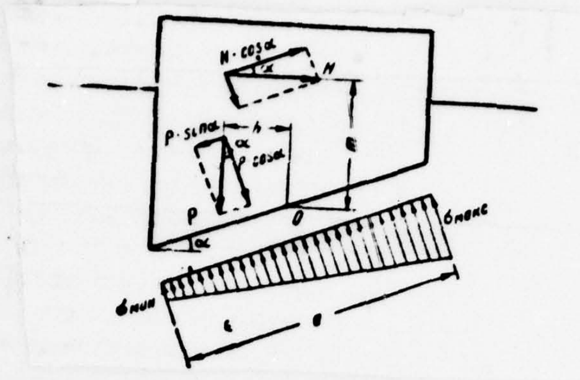

FIG. 15.37

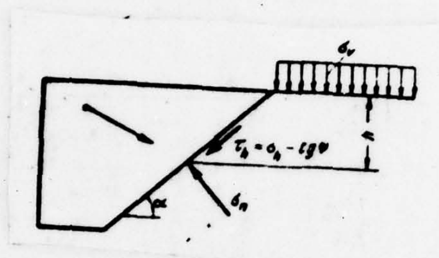

FIG. 15.38

Fig. 15.36. Different forms of stress diagrams under foundation level.

Key: (1). with.

Fig. 15.37. Diagram for determination of stresses under sloped foundation level.

Fig. 15.38. Circuit of passive resistance of soil before inclined wall.

h - the sinking of the point at which are determined the stresses, in m;

ϕ - the angle of the internal friction of soil in deg;

α - the angle of the slope of bottom the horizontal in deg;

ψ - the angle of friction from the contact between soil and bottom in deg;

e = 2.72.

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Value $tg\psi$ is numerically equal to the coefficient of the friction of the material of bottom on base.

With large single-valued horizontal loads most stressed works base under the forward section of the bottom. Therefore of foundations with inclined bottom for decrease in its sinking the tail section of the bottom in certain cases it is expedient to perform horizontal (Fig. 15.39).

The stresses in the base of such foundations can be determined analogous with stresses under foundations with inclined bottom.

As the conditional plane of an entire bottom, is accepted the plane of the bottom of the inclined forward section of the foundation, while as length a, is accepted the projection of the extreme points of bottom on the conditional plane of bottom AB.

The stresses in soil under foundation level with teeth

(Fig. 15.40), impregnated by vertical and horizontal forces, are checked using the common/general/total formula

$$\sigma_{\substack{\text{макс}\\\text{мин}}} = \frac{P_н}{F} \pm \frac{M_a}{W_a} \leq 1{,}2R_{гр}\ т/м^2,$$

where $P_н$ is a sum of all vertical loads of t;

F - the area of foundation level in m^2;

M_a - the sum of the moments of all forces relative to neutral axle/axis of direction a in tm;

W_a is a moment of resistance of bottom in the direction of torque/moment M_a in m^3;

$R_{гр}$ - the calculated resistance of soil at the depth of the laying of foundation level in t/m^2.

The moment of all forces in direction a is equal to

$$M_a = H_н h + E_1 m_1 + E_2 m_2\ тм,$$

where E_1 and E_2 are resultants of the resistance of soil before teeth in t;

m_1 and m_2 - distance from the resultants to E_1 and E_2 of bottom in m;

h - distance from bottom to horizontal load in m.

From the equation of the equilibrium

$$H_н = T + E_1 + E_2$$

it is determined is holding force of

$$E_1 + E_2 = H_н - T,$$

where T = Pf is holding force of friction p to bottom;

f - the coefficient of the friction of bottom in base.

With sufficient accuracy/precision it is possible to accept

$$m_1 = m_2 = \frac{h_2}{2}.$$

Calculation of foundations for stability to slip.

The calculation of foundations for stability to slip is produced on design loads; in this case the load factor to

the value of the holding load is accepted less than unity

For foundations with flat/plane horizontal bottom without taking into account of the side and frontal resistance of soil, the stability to shift/shear is provided with

$$H_p \leqslant P_p f\ \text{т}, \qquad (15.19)$$

where H_p is the shifting calculated horizontal load in t;

P_p - the sum of all vertical design loads t;

f - the coefficient of the friction of concrete in base.

For the constructions of supports with wide transverse wall and teeth under bottom (Fig. 15.41) the stability to shift/shear is checked using the formula

$$H_p < T + T_{\text{б}} + (E_{\text{п}} - E_{\text{а}}) + \Sigma(E_{\text{пз}} - E_{\text{аз}})\ . \qquad (15.20)$$

where $E_{\text{п}}$ and $E_{\text{а}}$ - the resulting calculated of the passive and active pressure of soil on wall in t;

$E_{\text{пз}}$ and $E_{\text{аз}}$ - the resulting calculated of passive and active pressure on tooth in t;

$T = P_p f$ - calculated holding force of friction on bottom

in t;

T_6 - the confining force of side friction in t;

P_D - a sum of all vertical forces t.

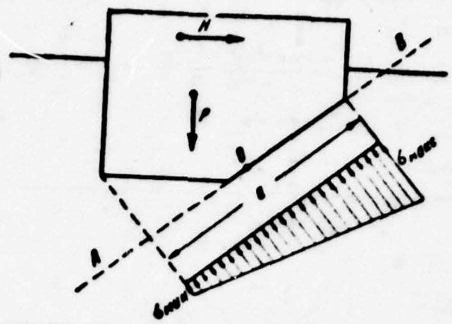

Fig. 15.39. Circuit to determination of stresses before inclined wall.

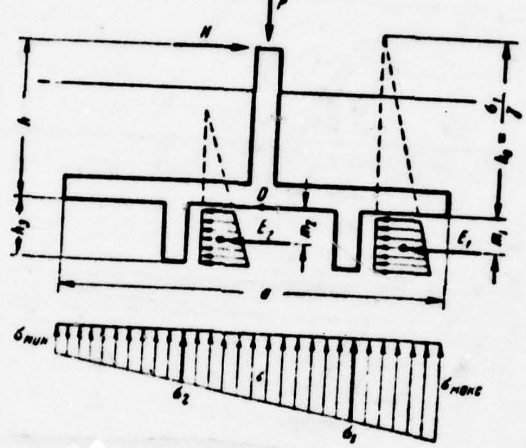

Fig. 15.40. Circuit to determination of stresses under bottom with teeth.

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The values, entering the formula (15.20), are determined from the given below formulas:

$$T_б = \gamma h^2 a \operatorname{tg}\varphi M_a \ т;$$
$$E_a = \frac{\gamma b h^2}{2} M_a \ т;$$
$$E_п = \frac{\gamma b h^2}{2} M_п \ т;$$
$$E_{a_з} = \frac{q_a^в + q_a^н}{2} h_з b \ т;$$
$$E_{п_з} = \frac{q_п^в + q_п^н}{2} h_з b \ т;$$
$$q_a^в = \sigma_з M_a \ т/м^2;$$
$$q_a^н = (\sigma_з + \gamma h_з) M_a \ т/м^2;$$
$$q_п^в = \sigma_з M_п \ т/м^2;$$
$$q_п^н = (\sigma_з + \gamma h_з) M_п \ т/м^2;$$
$$M_a = \operatorname{tg}^2\left(45^\circ - \frac{\varphi}{2}\right);$$
$$M_п = \operatorname{tg}^2\left(45^\circ - \frac{\varphi}{2}\right);$$

where γ - a calculated specific weight of soil in t/m^3;

ϕ - a calculated angle of internal friction in deg;

b - width of foundation in m;

h - a sinking of bottom in m;

$h_з$ - a height/altitude of tooth in m;

$\sigma_з$ - normal stress under bottom at the point before

the tooth in t/m^3.

For foundations with one tooth, arrange/located in the middle of the bottom

$$\sigma_{з} = \frac{P_{p}}{ab} \text{ и } \Sigma (E_{п_{з}} - E_{а_{з}}) = h\left(\frac{P_{p}}{ab} + \frac{\gamma h_{з}}{2}\right) \times \times (M_{п} - M_{а}) . \quad (15.21)$$

where P_p is a sum of all calculated vertical forces, including the weight of soil;

a and b - the side of foundation level.

For rectangular foundations with two teeth, symmetrically arrange/located relative to the middle of bottom,

$$\Sigma (E_{п_{з}} - E_{а_{з}}) = 2h_{з}\left(\frac{P_{p}}{ab} + \frac{\gamma h_{з}}{2}\right) \times \times (M_{п} - M_{а}) . \quad (15.22)$$

The small distance among teeth, and also distance from the first tooth to the forward edge of bottom is recommended to accept not less than the height/altitude $h_з$.

In foundations with two teeth, front/leading tooth

absorbs the load, greater than rear. Since the resistivity of soil before teeth to the action of horizontal loads depends on vertical stresses under bottom, distribution of horizontal loads between two teeth in practice is accepted to proration of stresses, i.e.,

$$\frac{E_1}{E_2}=\frac{\sigma_1}{\sigma_2} \quad \text{or} \quad E_1=E_2\frac{\sigma_1}{\sigma_2}.$$

where E_1 and E_2 - load on the first and second teeth in t;

σ_1 and σ_2 - stress under bottom respectively at the points before the first and second teeth in t/m^2.

The stability of foundations with flat/plane inclined bottom to slip is determined from the formula

$$H_p < \frac{fP_p\cos\alpha + P_p\sin\alpha}{\cos\alpha - f\sin\alpha}\,r. \qquad (15.23)$$

For an increase in the stability of foundations with flat/plane bottom to the action of horizontal loads bottom it should be frosted. In this case the coefficient of friction in bottom can be accepted equal to:

$$f=\mathrm{tg}\,\varphi.$$

where ϕ - a calculated angle of the internal friction of

the soil of base.

Stability analysis of shield supports.

With packing in impassable channels, horizontal axial load from the pipelines through the shield support is transferred to walls or walls and the bottom of channels. Reinforced-concrete panel in this case is designed, as the plate/slab, free along two or three sides, and the walls of channels are checked against warping.

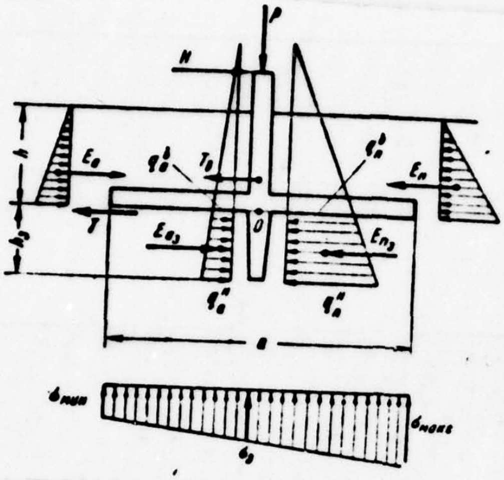

Fig. 15.41. Pattern of work of foundation with one tooth.

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The section of channel from support to the first rotation is checked against stability to axial shift/shear with respect to the formula

$$H_p < [b(2\gamma h + P_p) + \gamma L M_a (2h + L)] lf \text{ м}, \quad (15.24)$$

where h is an average sinking of the top of channel on section l in m;

b - the complete width of unicellular or multicellular channel in m;

L - the height/altitude of channel in m;

μ_p - calculated dead weight 1 lin. m. of channel in t;

f - the coefficient of the friction of canal surface against soil;

γ is a calculated specific weight of soil in t/m³;

l - the length of channel in m;

N_p - is total calculated axial load in T

$$M_a = tg^2\left(45° - \frac{\varphi}{2}\right).$$

Formula 15.24 is derived from the condition of the appearance of the confining forces of rhenium for entire perimeter of channel with the averaged coefficient of the friction of the material of channel against the ground.

The permissible axial load on 1 lin. m. of channel with the thickness of bottom, walls and overlaps on 100 it is possible to determine by the curve/graph of Fig.

15.42, constructed according to formula (15.24).

During the calculation of the shield supports, which transmit horizontal load from tubes on the vertical plane of ground, they use several methods.

According to the first method the bearing capacity of support is **determined from the formula**

$$H_p = F_{нетто} \cdot 0{,}5 R_{гр}\ т. \qquad (15.25)$$

where $F_{нетто}$ is the area of shield support, which comes into contact with soil, in m²;

$R_{гр}$ - the calculated resistance of soil at the depth of the laying of the axle/axis of tube in t/m².

According to the second method horizontal stress before the shield support define as for the foundation with vertical bottom, eccentrically impregnated by horizontal force,

$$\sigma_{\substack{макс \\ мин}} = \frac{H_p}{F_{нетто}} + \frac{H_p e}{W}\ т/м^2, \qquad (15.26)$$

where e is an eccentricity of the application/appendix of horizontal force in m;

W - a moment of resistance of the vertical "bottom" of panel in m^3.

The ordinates of stress diagram, determined by formula (15.26), must not exceed a difference in the ordinates of the diagram/curves of the passive and active pressure of the soil of those who were constructed according to calculated characteristics.

The supports, designed using the second method, have considerable reserve in view of the incomplete use of a bearing capacity of soil on the height/altitude of panel.

As the basis of the third method of calculation is placed the condition that the volume of stress diagram before the support on height/altitude from the top of support to any point C exceed the volume of the diagram/curve of the passive pressure, obtained at height/altitude from the earth's surface to the same point (Fig. 15.43).

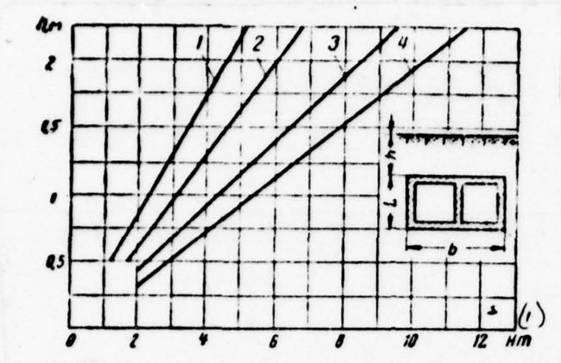

Fig. 15.42. Graph for value determination of resistance to longitudinal shift/shear 1 lin. m. of channel. 1 - for b = 1.1 m; L = 0.7 m; 2 - for b = 1.5 m; L = 0.9 m; 3 - for b = 2.2 m; L = 1 m; 4 - for b = 2.6 m; L = 1.3 m; h - the sinking of overlap; H is the standard shear strength 1 lin. m. of channel.

Key: (1). Nt.

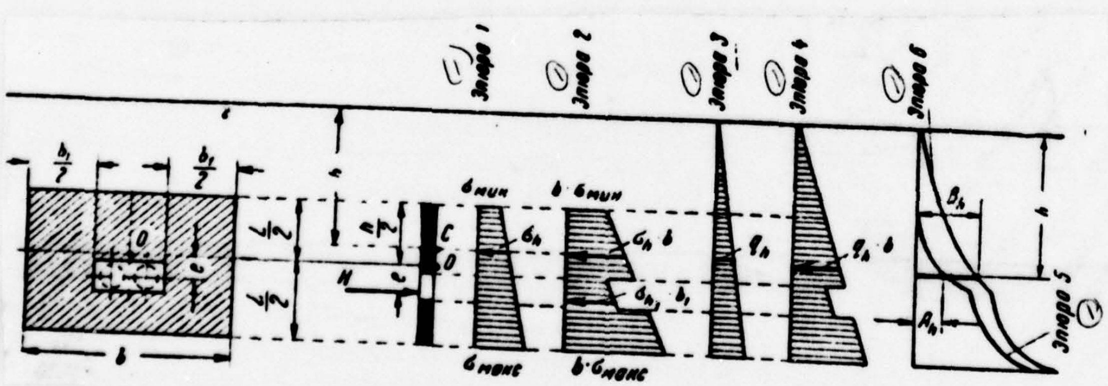

FIG. 15.43.

Fig. 15.43. Circuits on the calculation of stability of shield supports.

Key: (1). diagram.

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According to the third method the stability analysis conducted in the following order:

by formula (15.26) it is constructed the diagram of stresses σ before the panel (diagram/curve 1), which, as rule, takes the form of rectangle or trapezoid;

it is constructed the diagram/curve of the total pressure of wall in the width of support b and b_1 by means of the multiplication of ordinates σ_h by the width of wall (diagram/curve 2);

it is constructed the diagram/curve of a difference in the passive and active pressure (diagram/curve 3) by the formula

$$q_h = \gamma h (M_п - M_а)\ т/м^2;$$

it is constructed the diagram/curve of total pressure by means of the multiplication of ordinates q_h by b_1 and b (diagram/curve 4);

on diagram/curves 2 and 4, are constructed the curves diagram/curve 5 and 6. Any arbitrary ordinate A_h diagram/curves 5, arranged/located at point C at depth h from the earth's surface, is defined as area of the part of diagram/curve 2, of the arranged/located above point C.

Analogously from diagram/curve 4 is determined any ordinate B_h (diagram/curve 6).

Stability to the bulging of soil before the panel with respect to an entire height/altitude will be provided, if curve diagram/curves 5 completely render/shows inside curved diagram/curve 6, i.e., when at any point at depth h is provided the condition

$$B_h \geqslant A_h.$$

Stability analysis of the "rocking" foundations.

The calculation of supports under pipelines according to the type of the "rocking" foundations taking into account the passive resistance of soil consists in the determination of the displacement of face side under the action of horizontal force.

The amounts of the greatest displacement of face side of supports **are determined from the formula**

$$\Delta = \frac{2400HL^2}{C_2 bh^4} \text{ см}, \qquad (15.27)$$

where Δ is displacement of upper fulcrum into cm (value Δ should be allow/assumed not more than 2 cm) (Fig. 15.44);

L - the overall height of Panel in cm;

h - the sinking of panel in cm;

b is width of panel in cm;

H - the horizontal load, applied at the peak of panel, in kg;

C_2 - the compliance coefficient of soil at depth 2 m of surface in kg/cm³.

Compliance coefficient C_2 can be accepted:

1.5-2 - for the loamy and sandy loam soils of average density, and also for the mixtures of humus, sand and gravel with $\gamma = 1.5$ t/m³;

0.5-0.75 - for the irrigated loamy and sandy loam soil with $\gamma = 1.8$ t/m³;

2-3 - for moist dense clay with $\gamma = 1.6$ t/m³;

4-5 - for very dense clay with $\gamma = 1.8$ t/m³;

2-3 - for dry loess deposits with $\gamma = 1.6$ t/m³;

1-1.55 - for wet pure/clean light/lung sand with $\gamma = 2$ t/m³;

1.5-1.75 - for gravelly gravel with water with $\gamma = 1.9$ t/m³. With the width of panel, which exceeds 1.5-2 times its sinking, the formula gives somewhat understated amounts of displacement.

Stresses in soil before the panel at depth y from the earth's surface are determined from the formula

$$\sigma_y = \frac{C_1 y \Delta}{200L}(h - y) \text{ kg/cm}^2 \qquad (15.28)$$

where y is a distance from the point at which are determined the stresses, of up to the earth's surface.

For decrease in the value of "vibration" foundation areas under supports should be broken away in the form of narrow slots across the axle/axis of route, back filling is good to pack, and the upper third of supports to charge by the mixture of local soil with ballast.

Last/latter measure in soft ground makes it possible reduce the value of "vibration" to 50o/o.

The given formulas for determination Δ and σ are derived from the condition of the rotation of the vertical panel of support around their lower bound.

Therefore they can be applied only with observance of

the condition

$$P \geqslant \frac{H(2L-h)}{fh}. \quad (15.29)$$

where P - vertical load on support in kg;

H - the horizontal load, applied at Peak, in kg;

L is an overall height of panel in cm;

h - the sinking of panel in cm;

f - the coefficient of friction on the contact of the bottom of panel in base plate, and in the absence its - in soil.

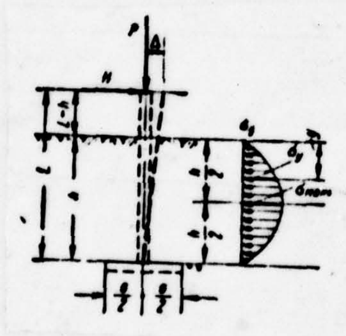

Fig. 15.44. Circuit on the calculation of "rocking" foundation.

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Section IV

Pumping and preheating installations, thermal point/items.

Chapter 16

QUALITY AND QUANTITY OF MAKEUP WATER OF WATER THERMAL NETWORKS.

16.1. Standard requirements for the quality of makeup water.

Depending on the type of water-heating equipment, source

of heat, calculated temperature of network water and adopted system, makeup water according to its basic indices must coorespond to the requirements, given in Table 16.1.

Makeup water for the open systems, furthermore, it must satisfy the requirements of GOST 2874-54.

Digressions from the Gost on the content of iron to 0.7-08 mg/l and transparency to 20 cm on type are allow/assumed according to agreement with the local organ/controls of state sanitary supervision in the following cases:

a) in the period of the incomplete mastery/adoption of the installations of hot water supply - by period to 1-2 months; b) in the period of the start of heating systems - by period to 7 days; c) into period it is flood.

Use for the additional feeding of the open systems of water from the system of reverse technical water supply with cooling towers or cooling ponds is not allow/assumed.

Table 16.1 shows the norm of conditional calcium sulfate rigidity, since the value of maximum rigidity, up

to which is eliminated precipitation from water $CaSO_4$, it depends on the concrete/specific/actual salt composition of initial water, methods of its treatment and value of solubility product $CaSO_4$ at the assigned/prescribed preheating temperature; it is determined in each individual case by calculation.

Table 16.1. Standard requirements for the quality of makeup water depending on the temperature of the network water

(1) Наименование показателей	(2) При установке стальных водогрейных котлов		(3) При установке подогревателей с латунными трубками	
	(4) при температуре сетевой воды в °С			
	(5) до 100	150	(5) до 100	150
Растворенный кислород в мг/л (6)	0,05	0,05	0,05—0,1*	0,05—0,1
Карбонатная жесткость в мг-экв/л (7)	0,7—0,9**	0,4—0,5***	0,7—1,5**	0,7
(8) Общая жесткость при использовании для подпитки воды непрерывной продувки котлов** в мг-экв/л	0,05	0,05	0,01	0,05
Величина pH (9)	7—9****			
Взвешенные вещества в мг/л (10)	5			
(11) Условная сульфатно-кальциевая жесткость в мг-экв/л	(12) Не больше величины, при которой возможно выпадение из воды $CaSO_4$			

NOTE. The norm of carbonate hardness for the intermediate values of the calculated temperature of network water from 100 to 150°C o is limited by interpolation.

Key: (1). Designation of indices. (2). During the installation of steel hot-waters boiler. (3). During the installation of preheaters with brass tubes. (4). at the temperature of network water in °C. (5). to. (6). Dissolved oxygen in mg/l. (7). Carbonate hardness in mg-equiv/liter. (8). Total hardness during use for the additional feeding of water of the continuous blasting of boilers ** in mg-equiv/liter. (9). PH value. (10). Suspended matter in mg/l. (11). Conditional sulfate-calcium rigidity in mg-equiv/liter. (12). It is not

more the value with which is possible the precipitation from water $CaSO_4$.

FOOTNOTE * The norm of oxygen 0.05 mg/l is accepted in the open systems, and 0.1 mg/l - with closed.

** The norm of carbonate hardness of more than 0.7 mg-e/liter is allow/assumed to apply in the oxidizability of water of more than 6 mg/l O_2.

*** The lower limit of the norm of the carbonate hardness of 0.4 mg-equiv/liter is accepted for gas-oil hot-waters boiler, and upper 0.5 mg-equiv/liter for hot-waters boiler on solid fuel.

**** In the open system the use for the additional feeding of water of the continuous blasting of boilers is not permitted, and pH value of makeup water must not exceed 8.5. ENDFOOTNOTE.

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The stability of water on $CaSO_4$ can be tested according to the equation

$$[Ca^{2+}] \cdot [SO_4^{2-}] f_{II}^2 = \Pi P\ CaSO_4, \qquad (16.1)$$

where $[Ca^{2+}]$ and $[SO_4^{2-}]$ are the maximally permissible ion concentration of calcium and sulfate-ion into g-ion in 1 l; f_{II} is an activity coefficient of bivalent ions; PR $CaSO_4$ - solubility product $CaSO_4$ into g-ion in 1 l.

Activity coefficient is determined from the formula

$$\lg f = -0{,}5Z^2 \frac{\sqrt{\mu}}{1+\sqrt{\mu}}, \qquad (16.2)$$

where Z is a valence of ion; μ - ionic force of solution.

For the bivalent ions

$$\lg f_{II} = -2 \frac{\sqrt{\mu}}{1+\sqrt{\mu}}. \qquad (16.3)$$

The ionic force of solution μ is equal to the half-sum of the products (in g-ion/l) of all ion concentrations by the square of their valences:

$$\mu = \frac{1}{2}\ 10^{-3} \left[\Sigma AZ^2 + \Sigma БZ_1^2\right], \qquad (16.4)$$

where ΣA - a sum of all bivalent ion concentrations of g-ion/l;

$\Sigma Б$ - the same, monovalent ions; Z and Z_1 - valence.

The value of solubility product $CaSO_4$ is accepted according to Table 16.2.

In accordance with the composition of initial water, is produced the calculation regarding the maximum permissible value of sulfate-ion (conditional sulfate-calcium rigidity) in network water.

For the conversion of the obtained as a result of calculation value of the maximum permissible concentration of sulfate-ion in sulfate-calcium rigidity in mg-equiv/liter, the obtained value is multiplied by $2 \cdot 10^3$ (where 2 - the valence of sulfate-ion).

Example 1. To determine the limiting value of conditional sulfate-calcium rigidity (maximum permissible value of sulfate-ion) for the water, heated to 150°C and which has the initial composition, given in Table 16.3.

The ion force of solution will comprise by formula (16.4).

$$\mu = \frac{1}{2} 10^{-3} [(2.53 + 0.8 + 0.64) 2^2 + (0.3 + 5.4 + 0.23) 1^2] = 0.0109.$$

Activity coefficient of bivalent ions according to formula (16.3)

$$\lg f_{11} = -2\frac{\sqrt{0.0109}}{1+\sqrt{0.0109}} = -0.187 = \bar{1}.813,$$

whence $f_{11} = 0.65.$

From Table 16.2 it is determined PR $CaSO_4$ at the temperature of the network water t = 150°C:

$$\text{ПР } CaSO_4 = 1.4\cdot10^{-6} \text{ g-ion/l.}$$

Substituting in equation (16.1) the obtained values for the maximum permissible value of sulfate-ion in water we determine the value

$$\left[SO_4^{2-}\right] = \frac{1.4\cdot10^{-6}}{2.53\cdot10^{-3}\cdot0.65^2} = 1.31\cdot10^{-3}\ \overset{(1)}{\text{г-ион/л}},$$
$$\overset{(2)}{\text{или}}\ 1.31\cdot10^{-3}\cdot2\cdot10^3 = 2.62\ \overset{(3)}{\text{мг-экв/л}}.$$

Key: (1). g-ion/l. (2). or. (3). mg-equiv/liter.

which exceeds the content SO_4^{2-} in initial water. Consequently, the work of network at temperature of 150°C will be completely reliable.

Example 2. To determine maximally allowable values of sulfate-ion for makeup water at the preheating of network water to 120° and 160°C. The composition of water is given in Table 16.4.

Ionic force of solution by formula (16-4).

$$\mu = \frac{1}{2}\,10^{-3}[(3.10 + 1.07 + 2.58)\,2^2 + (4.63 + 4.12 + 3.36)\,1^2] = 0.0196.$$

The activity coefficient of bivalent ions agree to formula (16-3)

$$\lg f_{II} = -2\,\frac{\sqrt{0.0196}}{1 + \sqrt{0.0196}} = -0.246 = \bar{1}.754,$$

whence

$$f_{II} = 0.568.$$

Table 16.2. Solubility product $CaSO_4$ depending on the calculated temperature of network water.

(1) Температура сетевой воды в °C	90	100	120	160	200
(2) ПР $CaSO_4$ в г-ионах/л	$11,3 \cdot 10^{-6}$	$7,6 \cdot 10^{-6}$	$3,7 \cdot 10^{-6}$	$0,93 \cdot 10^{-6}$	$0,24 \cdot 10^{-[illegible]}$

Key: (1). Temperature of network water in °C. (2). in g-ion/l.

Table 16.3. Data of the analysis of water.

(1) Наименование показателей	(2) Концентрация в		
	(3) мг/л	(4) мг-экв/л	(5) г-ион/л
Ca^{2+}	101,1	5,05	$2,53 \cdot 10^{-3}$
Mg^{2+}	19,3	1,59	$0,8 \cdot 10^{-3}$
Na^{+}	7	0,3	$0,3 \cdot 10^{-3}$
HCO_3^{-}	329,5	5,4	$5,4 \cdot 10^{-3}$
SO_4^{2-}	60,8	1,27	$0,64 \cdot 10^{-3}$
Cl^{-}	8	0,23	$0,23 \cdot 10^{-3}$
(6) Сумма ионов	525,7	13,84	$9,9 \cdot 10^{-3}$

Key: (1). Designation of indices. (2). Concentration v. (3). mg/l. (4). mg-equiv ~~kg-e~~/liter. (5). g-ion/l. (6). Sum of ions.

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Solubility product $CaSO_4$ for the temperature of network water -120°C according to table 16.2 will comprise $3.7 \cdot 10^{-6}$.

Limiting value of sulfate-ion from equation (16.1)

$$\left[SO_4^{2-}\right] = \frac{3.7\cdot 10^{-6}}{3.1\cdot 10^{-3}\cdot 0.568^{2}} = 3.7\cdot 10^{-3}\ \text{г-ион/л.}^{(1)}$$

$$^{(2)}\text{или}\ 3.7\cdot 10^{3}\cdot 2\cdot 10^{-3} = 7.4\ \text{мг-экв/л.}^{(3)}$$

Key: (1). g-ion/l. (2). with (3). mg-equiv/liter.

Solubility product $CaSO_4$ for the temperature of network water 160°C on Table 16.2 will compose $0.93\cdot 10^{-6}$ g-ion/l and the limiting value of sulfate-ion from equation 16.1.

$$\left[SO_4^{2-}\right] = \frac{0.93\cdot 10^{-6}}{3.10\cdot 10^{-3}\cdot 0.568^{2}} = 0.93\cdot 10^{-3}\ \text{г-ион/л.}^{(1)}$$

$$^{(2)}\text{или}\ 0.93\cdot 10^{-3}\cdot 2\cdot 10^{3} = 1.86\ \text{мг-экв/л.}^{(3)}$$

Key: (1). g-ion/l. (2). or. (3). mg-equiv/liter.

In the work of network at the temperature of network water, 160°C limiting value of sulfate-ion in water was obtained its below value in initial water (5.16 mg-equiv/liter); therefore water will be unstable at this temperature and will separate out sulfate-calcium salts on equipment and the conduit/manifolds of heating system. At the temperature of network water 120°C, maximally permissible value of sulfate-ion there will be 7.4 mg-equiv/liter, i.e., considerably its higher than value in initial water (5.16 mg-equiv/liter), and sulfate-calcium salts separate out will not be.

16.2. Quantity of makeup water and the productivity of water treatment.

A quantity of makeup water must strictly correspond to a value of leakage and to a quantity of water, selected in the open systems of hot water supply.

The hourly mean value of leakage for year according to "technical operation instructions of electrical stations and networks" is accepted equal to 0.25o/o of the volume of water in the conduit/manifolds of thermal networks and the directly connected to them local systems of buildings.

The calculated value (norm) of additional feeding $G_{\text{п}}^{\text{у}}$ in m^3/h, taking into account possible fluctuations of leakage during one year depending on regime of operating conditions of system, it is accepted equal to 0.5o/o of the volume of water in the conduit/manifolds of thermal networks and directly connected up them local systems of buildings.

The volume of water in the conduit/manifolds of thermal networks is determined according to compound specification to tubes depending on and the extent and diameter.

The specific volume of water in conduit/manifolds depending on diameter is given in Table 16.5.

The specific volume of water in the local heating systems and ventilation of the connected buildings is accepted according to Table 16.6.

The specific volume of water in the local systems of hot water supply takes as equal to 6 m^3 on 1 gcal/h of the neutral calculated thermal load of hot water supply.

In the absence of precise information about the type of heating instruments, is allow/assumed tentatively to accept the specific volume of water in local systems of the heating of buildings according to entire object on 1 gcal/h of the total calculated hourly consumption of the heat: for residential areas 30 m^3, for industrial enterprises 15 m^3.

Taking into account the specific volume of water in the conduit/manifolds of thermal networks and preheating installations the total volume of water in system it is

allowed tentatively to accept upon 1 gcal/h of total calculated heat consumption: for residential areas 45-50 m^3; for industrial enterprises 25-35 m^3 with the refinement of the obtained values at the subsequent stages of planning.

Table 16.4. Data of the analysis of water.

(1) Наименование показателей	(2) Концентрация в		
	(3) мг/л	(4) мг-экв/л	(5) г-ион/л
Ca^{2+}	124,4	6,2	$3,10 \cdot 10^{-3}$
Mg^{2+}	26	2,14	$1,07 \cdot 10^{-3}$
Na^{+}	107	4,65	$4,65 \cdot 10^{-3}$
HCO_3^{-}	252,6	4,12	$4,12 \cdot 10^{-3}$
SO_4^{2-}	246,5	5,16	$2,58 \cdot 10^{-3}$
Cl^{-}	119	3,36	$3,36 \cdot 10^{-3}$
(6) Сумма ионов	875,5	25,64	$18,88 \cdot 10^{-3}$

Key: (1). Designation of indices. (2). Concentrations v. (3). mg/l. (4). mg-equiv/liter. (5). g-ion/l. (6). Sum of ions.

Table 16.5. The specific volume of water in m^3/km depending on the diameter of tubes.

(1) Диаметр трубы $D_{усл}$ в мм	(2) Объем воды в $м^3$/км	(1) Диаметр трубы $D_{усл}$ в мм	(2) Объем воды $м^3$/км
25	0,6	400	135
40	1,3	450	170
50	1,4	500	210
100	8	600	300
125	12	700	390
150	18	800	508
200	34	900	640
250	53	1000	785
300	75	1100	947
350	101	1200	1120

Key: (1). Diameter of tube in mm. (2). Volume of water in m^3/km.

Table is 16.6 specific volumes of water in the local

heating systems and ventilation in m^3 in 1 gcal/h of calculated thermal load.

(1) Тип нагревательных приборов	(2) Принятий перепад температур в местной системе в °C	
	95/70	130/70
(3) Чугунные емкие радиаторы типов «Гамма», «Польза»	35	25
Радиаторы малой емкости Н и М (4)	25	16
Ребристые трубы или конвекторы (5)	14	11
Панели со змеевиками из труб (6).	10	—
Пластинчатые калориферы (7) . .	8,5	6,5

Key: (1). Type of heaters. (2). Acceptances the temperature differential in local system in °C. (3). Cast iron large-capacity radiators of types "Gamma", "Pol'za". (4). Radiators of low capacitance/capacity N and M. (5). Finned tubes or convectors. (6). Panels with coils from tubes. (7). Lamellar heaters.

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A quantity of makeup water for hot water supply determines according to calculated heat consumption for hourly mean

$$G^{cp}_{г.в} = \frac{Q^{cp}_{г.в}}{t_р - t_{х.в}} \quad m^3/h \qquad (16.5)$$

maximum hourly

$$G^{макс}_{г.в} = \frac{Q^{макс}_{г.в}}{t_р - t_{х.в}} \quad m^3/h \qquad (16.6)$$

where $Q^{cp}_{г.в}$ and $Q^{макс}_{г.в}$ - with respect by hourly mean calculated heat consumption for the days of

the greatest water consumption and the maximum hourly consumption of heat for hot water supply, determined in Chapter 7; t_p is the calculated temperature of the take/selected from thermal network water, taken equal to 60°C (in the absence of the special requirements). $t_{x.в}$ is the calculated temperature of the cold water, which enters the heat source and taken equal to 5°C (in the absence of the special requirements).

The productivity of water treatment for the treatment of makeup water G_n in m³/h is accepted:

for the additional feeding of the closed systems

$$G_п = G_п^у \text{ m/h.}$$

For the additional feeding of the open systems or separate conduit/manifolds of hot water supply:

a) during the installation of local or central tank-storage battery/accumulators on treated water

$$G_п = G_{г.в}^{ср} + G_п^у \text{ m}^3/\text{h} \qquad (16.7)$$

b) in the absence of tank-storage battery/accumulators or during the installation of central tank-storage battery/accumulators on the untreated cold water

$$G_п = G_{г.в}^{макс} + G_п^у \text{ m}^3/\text{h} \qquad (16.8)$$

Designations on preceding/previous.

16.3. Central tank- storage battery/accumulators.

With large quantities of makeup water in the open systems of thermal networks (from 150 m^3/h it is above), is provided for the installation of central tank- storage battery/accumulators, leveling curve/graphs of the load of everyday hot water supply for the days of the greatest water consumption.

In certain cases is provided for the installation of tank-storage battery/accumulators, which level load per week of winter period.

When the diurnal or weekly graphs of the load of hot water supply are absent, the capacitance/capacity of tank-storage battery/accumulators $V_б$ for the load of residential areas can approximately be determined from the formulas:

diurnal

$$V_б^c = (4-6)G_{г.в}^{ср} \ м^3; \quad (16.9)$$

weekly

$$V_6'' = (8-10)\, G_{r.n}^{cp}\ м^3, \qquad (16.10)$$

where $G_{r.n}^{cp}$ - hourly mean the consumption of water for hot water supply for the days of the greatest water consumption in m^3/h.

In tanks is accumulated the deaerated water; therefore it must be protected from the incidence/impingement into it of atmospheric oxygen.

most reliable is the device of steam pillow with overpressure pair 1.5-2 m water column.

Central battery tanks, as a rule, are placed on territory of heat and power plant or boiler room and according to circuit are included consecutively with deaerator.

In the thermal networks of some cities the battery tanks of thermal users.

16.4. Application/appendices.

Unity of water hardness

German degrees: $1^{\circ}_{нем} = 10$ mg CaO in 1 l of water.

French degrees: $1^{\circ}_{франц} = 10$ mg $CaCO_3$ in 1 l of water.

English degrees: $1^{\circ}_{англ} = 10$ mg $CaCO_3$ in 0.7 l of water.

American degrees: $1^{\circ}_{амер} = 1$ mg $CaCO_3$ in 1 l of water.

Soviet unit of rigidity: 1 mg-e (equiv) = 28 mg CaO in 1 l of water.

Relationship between the indicated values: 1 mg-e (equiv) = $= 2{,}8^{\circ}_{нем} = 3{,}5^{\circ}_{англ} = 5^{\circ}_{франц} = 50^{\circ}_{амер}$.

1 g.-equiv. = 1000 mg-equiv.

1 μg-equiv. = 1/1000 mg-equiv.

Table 16.7. Solubility of oxygen in water in mg/l depending on temperature.

(1) Температура в °C	10	20	30	40	50	60	70	75	80	85	90	100
(2) Содержание O_2 в мг/л	11,2	9	7,5	6,35	5,5	4,7	3,8	3,3	2,8	2,2	1,6	0

Key: (1). Temperature in °C. (2). Content of O_2 in mg/l.

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Chapter 17

PUMPING STATIONS.

17.1. Fundamental characteristics of pumping stations.

The network pumping of the preheating installations of heat sources are intended for the circulation of water in two- and three-tube water thermal networks and for a water supply to users on single-pipe water network.

A quantity of network pumps is accepted not less than two, of which one standby.

With the number of in parallel working network pumps more than three according to SNIP II-G.10-62 the installation of standby pump is optional.

The efficiency of workman of network pumps is accepted equal to the calculated consumption of network water in preheating installation (see Chapter 9); the productivity of standby pump - capacity of one working pump.

The pump head for two-funnelled networks is taken as equal to the sum of hydraulic losses of pressure (with the calculated consumption of water) of preheating installation, of feeding and return lines of thermal network, counting from heat source to the most removed user, and of the local system of this user.

Before network pumps are installed sludge pans for the catching of foreign object/subjects, randomly caught in hot water pipes during installation and repair.

The network booster pumping are establish/installed on that which feeds and on return lines of water thermal networks.

Figures 17.1 and 17.2 shows schematic diagrams the booster pumping on reverse/inverse and delivery pipes.

In pumping on the conditions of providing the

reliability of operation, it is establish/installed on two working pumps and one standby.

To avoid hydraulic impact with sudden emergency shutdown of booster pump on return line around pump, is provided for bypass line with check valve.

When in users with stop the booster pumping can be raised pressure higher than permissible, special attention it is given to the reliability of their operation, for which it is provided for the bilateral feeding of electric motors from two different sources or two transformer points with the possibility of switching if necessary from one power supply to another.

Circuit and equipment for the automation of pumping are given in Chapter 20.

Table 17.1 gives fundamental characteristics the network booster pumping on feeding and return lines.

Network mixing pumping. The head of mixing pumps must exceed maximally possible available system head of the point/item of the arrangement/position of pumping on 5-10 m

water column.

In mixing pumping it should be set to three pumps, of which one standby. For small pumping are allow/assumed to establish/install two pumps, of which one - standby.

Circuit by mixing pumping for two-funnelled thermal networks is given in Fig. 17.3.

Approximate dimensions and equipment of mixing pumping stations are given in Table 17.2.

Productivity mixing pumping $G_{см.н}$ can be determined by the formula

$$G_{см.н} = aG_{под}\ t/h \qquad (17.1)$$

where $G_{под}$ is consumption of water in delivery pipe to the pumping in t/h; ¶ a is the calculated mixing factor, determined according to the equation

$$a = \frac{\tau_1 - \tau_3}{\tau_3 - \tau_2}. \qquad (17.2)$$

Here τ_1, τ_2 and τ_3 are temperatures respectively in feeding and return lines to mixing and in delivery pipe after mixing at the calculated temperature of surrounding air for a heating.

The temperature of water after mixing or the assigned/prescribed mixing factor is recommended to support with automatic regulators (see Chapter 20).

Feed pumping (see Fig. 17.1) are intended for the compensation for leakage and analysis/selection of water from thermal network. ¶ Pressure of makeup pumps is determined from static pressure in system at the temperature of water to 100°C taking into account the pressure of water on the suction line and is checked for the provision for a noneffervescence of water in delivery pipe during the circulation of water in system.

During installation in the open systems of tank-storage battery/accumulators for selecting the pump capacity, are considered the hourly mean consumption of water for hot water supply, and also water leak (see chapters 9 and 17).

Exemplary/approximate characteristics feed pumping are given in Table 17.3.

In the large systems of heat supply, is recommended the setting up of the separate groups of feed pumps for summer and winter periods.

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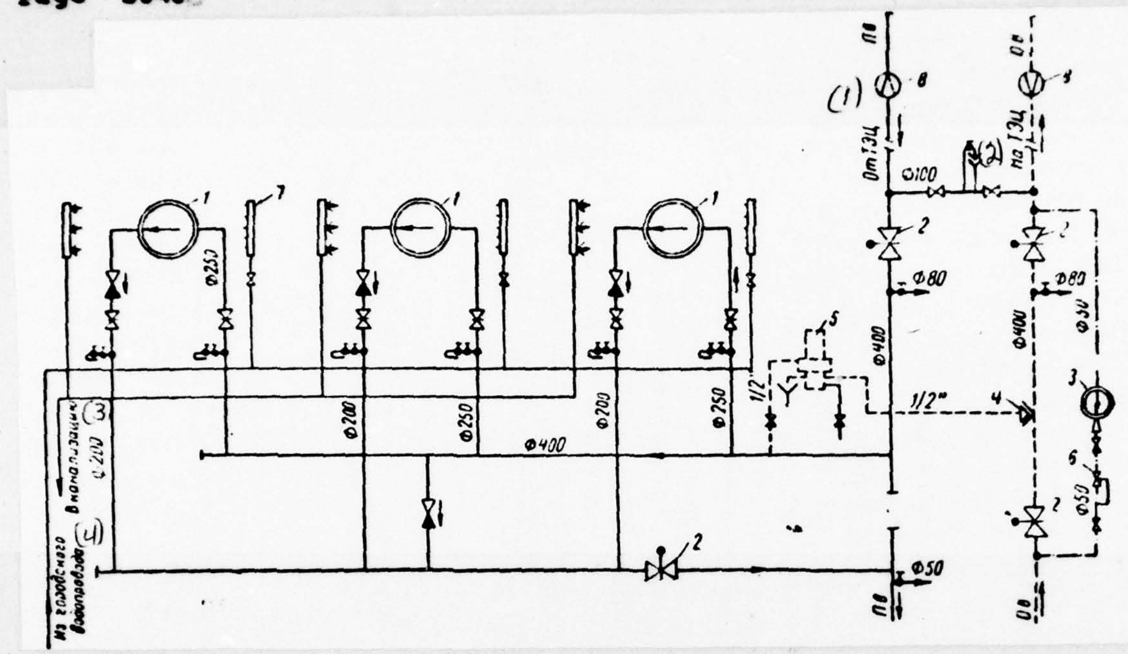

Fig. 17.1. Circuit of boost pumping on supply line. 1 network booster pumps; 2 - electrified catches; 3 - makeup pump for closed networks; 4 - valve of breaking; 5 - pressure relay; 6 - pressure regulator; 7 - supply of water for cooling bearings; 8 - measuring diaphragms, adjustable on direct/straight section of tube (by outside pumping); p. in feeding water; Is. C - reverse/inverse water.

Key: (1). From. (2). On. (3). In channelization. (4). From urban water pipe.

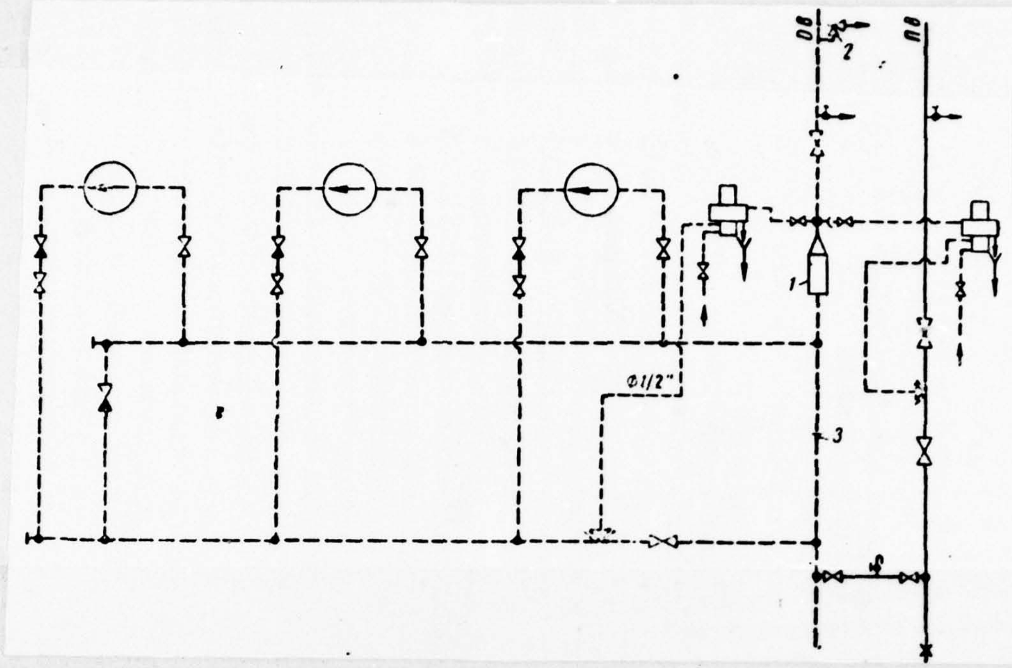

Fig. 17.2. Circuit by booster pumping on return line 1 - sludge pan; 2 - safety valves (2 pcs.); 3 - plug/silencer.

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Condensate pumping are intended for the evacuation of condensate from receiver tanks; they usually are erected in users pair, that have the large yield of condensate (more than 3 t/hs).

Arrangement/position condensate pumping in the separate

underground locations is not recommended.

In condensate pumping (Fig. 17..4 and 17.5) is establish/installed not less than two pumps of which one standby.

The pump capacity for the pumping of condensate is selected on the maximum hour return of condensate from users.

In the work of several condensate substations for one common/general/total condensate piping, the pressures of the pumps of all substations must be selected so that the static pressure, created by pumps taking into account geodetic marks, will be identical.

Table 17.1. Characteristics and basic dimensions the network of boost pumping on reverse/inverse and delivery pipes according to the data of the Kharkov department/separation of VGPI of Electroheat-plan.

(1) Место установки насосов	(2) Диаметр труб тепловой сети в мм	(3) Насосы (3 шт.)				(4) Электродвигатели (3 шт.)					(5) Пределы применения		(6) Размеры помещения в м	
		(7) тип	(8) производительность в м³/ч	(9) напор в м вод. ст.	(10) вес в т	(7) тип	(11) мощность в квт	(12) число оборотов в мин	(13) напряжение тока в в	(10) вес в т	(14) по производительности в м³/ч	(15) по напору в м вод.ст.	(16) длина	(17) ширина
(18) На обратной трубе	300	6НД$_в$	250	54	0,3	А-82-4	55	1500	220/380	0,4	400—800	55—43	12	9
	350	8НД$_в$	400	32	0,95	А-91-6	55	1000	220/380	~1	300—600	34—24	12	9
	600	12НД$_с$	1260	64	1,4	А-111-4	250	1500	220/380	1,5	1800—2800	70—58	18	12
	400	10СД-6	485	65	1,4	А-102-4	160	1500	220/380	1,1	500—1200	78—61	18	9
(19) На подающей трубе	500	12СД-9	790	54	1,6	А-103-4	200	1500	220/380	1,2	600—1000	62—45	18	9
	500	12СД-10×2	790	90	3,2	А-112-4	320	1500	220/380	1,6	1200—1800	—	18	12
	700	14СД-10×2	1260	123	4,9	ДАМСО-157-4	600	1480	6000	1,5	—	—	24	12
						ДАМСО-1410-4	680	1480	3080	3,55	—	—	—	—

Key: (1). Site of installation of pumps. (2). Diameter of the tubes of thermal network in mm. (3). Pumps (3 pcs.). (4). Electric motors (3 pcs.). (5). Apparitors of application/use.? (6). Size/dimensions of location in m. (7). type. (8). productivity in m³/h. (9). pressure in m water column. (10). weight in t. (11). power in kW. (12). speed in min. (13). the voltage in v. (14). on productivity in m³/h. (15). on pressure in m water column. (16). length. (17). width. (18). On run-back. (19). on supply pipe.

Table 17.2. Exemplary/approximate size/dimensions mixing pumping depending on a quantity of mixed water.

(1) Количество подмешиваемой воды в $м^3/ч$	(2) Насосы (3 шт.)		(3) Примерные размеры насосных в м	
	(4) производительность в $м^3/ч$	(5) напор в м вод. ст.	(6) длина	(7) ширина
500	250	35	9	6
1000	500	45	12	9
2000	1000	60	18	9
3000	1500	70	18	9
4000	2000	80	18	12

Key: (1). Quantity of mixed water in m^3/h. (2). Pumps (3 pcs.). (3). Exemplary/approximate size/dimensions of pumping in m. (4). productivity in m^3/h. (5). pressure in m water column. (6). length. (7). width.

Table 17.3. Exemplary/approximate characteristics feed pumping.

(1) Система горячего водоснабжения	(2) Место установки подпиточных насосов	(3) Производительность насосной в $м^3/ч$	(4) Напор насосов в м вод. ст.	(5) Количество насосов (не менее) в шт.
(6) Закрытая	(7) В узлах рассечки сети на зоны	30—60	20—70	1
(8) Открытая		100—500	20—70	2
	(9) В подогревательных установках сетевой воды источника тепла	30—250	30—70	2
		100—1000	30—70	3

Key: (1). System of hot water supply. (2). Site of installation of makeup pumps. (3). Productivity of pumping in m^3/h. (4). Pump head in m water column. (5). A quantity of pumps (is not less in pcs. (6). Closed. (7).

In the units of the crosscut of network to zones. (8). Opened. (9). In the preheating settings up of network water of heat source.

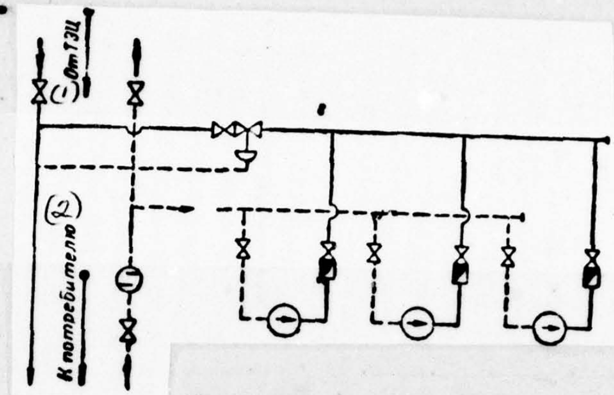

Fig. 17.3. Circuit by mixing pumping for two-funnelled thermal networks.

(1). From. (2). To user.

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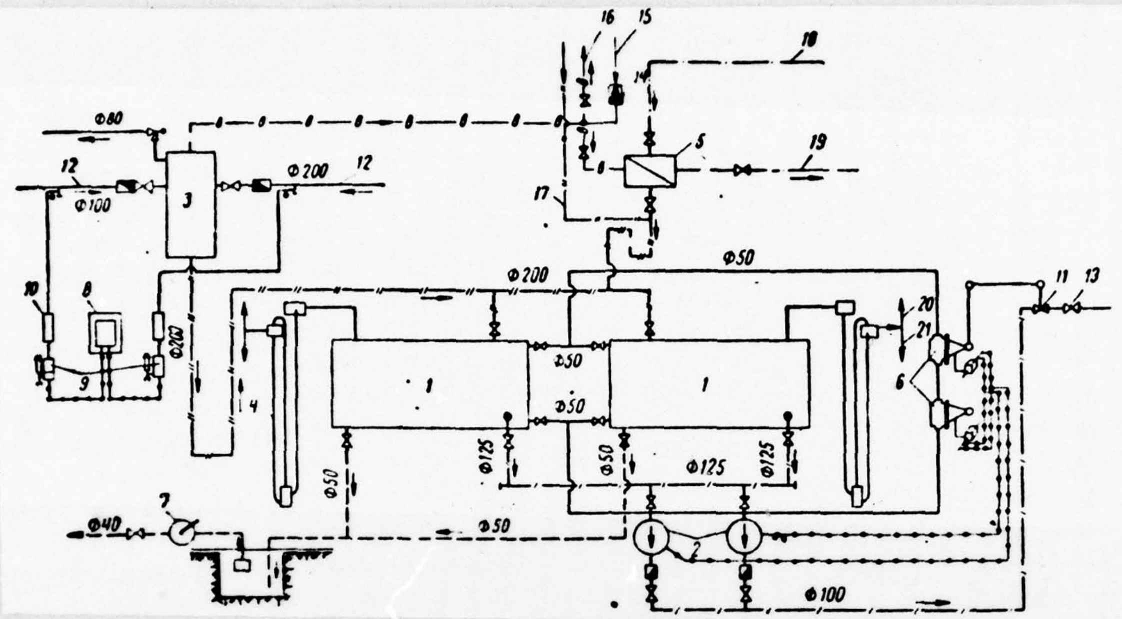

Fig. 17.4. Circuit by condensate pumping with expansion tanks 1 - condensate tanks; 2 - pumps; 3 - expansion tank; 4 - hydraulic safety device/fuse; 5 - heat exchanger of secondary steam (p = 1.2 atm(abs.)); 6 - float relays; 7 - hand pump for evacuation of drainage water; 8 - salinometer; 9 - sensor of salinometer; 10 - cooler; 11 - control valve; 12 - condensate piping from users; 13 - forcing condensate piping; 14 - reducer; 15 - pairs from shop; 16 - pairs for heating and ventilation (v = 1.2 atm(abs.)); 17 - condensate piping is pair from shop (p = 1.2 atm(abs.)); 18 - cold water; 19 - hot water for use; 20 - ejection in the atmosphere; 21 - issue into

channelization.

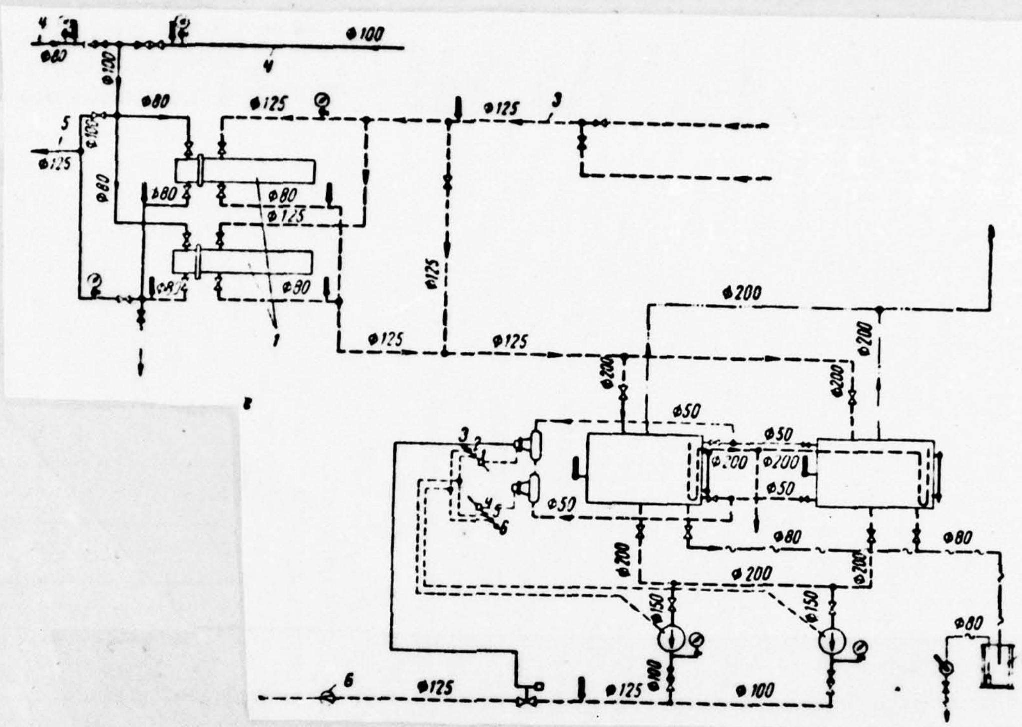

Fig. 17.5. Circuit of condensate pumping with the coolants of condensate 1 - coolant of condensate; 2 - pit; 3 - condensate piping from users; 4 - return lines of network water; 5 - heated water into network; 6 - measuring diaphragm.

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A quantity of tanks in pumping is accepted, as a rule, it is not less than two by capacitance/capacity on

50o/o each. In the seasonal work of pumping, is allow/assumed the setting up of one tank.

The working capacitance/capacity of receiver tanks of condensate with its automated evacuation must be not the less 10-minute maximum entrance of condensate from users, and if necessary for the quality control of condensate - not less than 20- minutes.

With the return of condensate along closed system in composite condensate tank, must be supported the overpressure within limits 0.05-0.2 kg/cm². Overpressure can be created because of the separated vapor or pair from heat sources.

Is allowed the jettisoning of condensate into the systems of channelization; in this case: a) with constant jettisoning into the system of everyday channelization should provide for cooling condensate down to 40°C; with flood gate the condensate is not cooled; b) with constant and flood gate into the system of rain channelization condensate is not cooled.

Condensate tanks must have overflow pipes with water lock in the form of loop for the protection of tank from

overfilling and from a pressure increase of steam pillow.

Characteristics and the size/dimensions of several types of condensate substations, according to data of VGPI Electroheat-plan, are given in Table 17.4 and 17.5.

At the temperatures of assembled condensate above 120°C its heat is recommended to utilize in users.

Heat of condensate is possible to utilize: a) by cooling hot condensate in heat exchangers (coolants) to 95-100°C; b) by obtaining from hot condensate the pair of secondary effervescence in the expansion tanks with its use in of various kinds heat exchangers, including heating-ventilating instruments.

The expansion tanks are establish/installed above condensate tanks so that the bottom of the expansion tank would be not less than on 0.3-0.5 m higher than the level of the entering the tank condensate tube.

The supply of condensate to Baku must be produced into the lower part of the tank under the minimum level of condensate at a distance from below the tube to the bottom

of tank not less than 100 mm.

The marks of the setting up of condensate tank and pumps must provide altitude difference between the minimum level of condensate in tank and the axle/axis of pump, sufficient for the prevention/warning of cavitation in the suction part of the pump.

Table 17.4. Characteristics and the basic dimensions of condensate pumping substations with the expansion tanks according to data of VGPI of Electroheat-plan.

(1) Тип насосных	(2) Количество откачиваемого конденсата в м³/ч	(3) Диаметр напорных конденсатопроводов в мм	(4) Насосы (2 шт.)			(5) Электродвигатели (2 шт.)				(6) Конденсатные баки (2 шт.)		(7) Размеры подстанции в м			(19) Помещение подстанции
			(8) тип	(9) производительность в м³/ч	(10) напор в м вод. ст.	(8) тип	(11) мощность в квт	(12) число оборотов в мин	(13) емкость расширительного бачка в м³	(14) емкость (рабочая) бака в м³	(15) номер междуведомственной нормали	(16) длина	(17) ширина	(18) высота	
I	До 5	50	2-К6	5	34,5	А-41-2	2,8	2900	0,25	1	—	5	5	3,5	Закрытое (20)
II	» 10	80	2-К6	10	34,5	А-42-2	4,5	2900	0,25	2	2102-01	5 7	5 5	3,8 3,8	Полузакрытое (21) Закрытое (22)
III	» 25	100	3-К9	25	35	А-51-2	7	2900	0,7	4	2102-02 или (23) 2120-01	5 7,5	6,5 6,5	4,2 4,2	Полузакрытое (21) Закрытое (22)
IV	» 50	125	3-К6а	50	37,5	А-61-2	14	2900	1	10	2102-05 или (23) 2107-01	5 7,5	7 7	4,7 4,7	Полузакрытое (21) Закрытое (22)
V	» 100	150	6К-8	100	37	А-72-4	28	1450	1	15	2102-06 или (23) 2107-02	9 12	9 9	5 5	Полузакрытое (21) Закрытое (22)
VI	» 200	200	6НДС	250	66	А-82-2	75	2950	1 (2 шт.)	25	746-01 или (23) 775-01	9 12	12 12	5,5 5,5	Полузакрытое (21) Закрытое (22)

Key: (1). Type of pumping. (2). Quantity of evacuated condensate in m³/h. (3). Diameter of boost condensate pipings in mm. (4). Pumps (2 pcs.). (5). Electric motors (2 pcs.). (6). Condensate tanks (2 pcs.). (7). Size/dimensions of substation in m. (8). type. (9). Productivity in m³/h. (10). pressure in m water column. (11). power in kW. (12). speed in min. (13). the capacitance/capacity of the expansion tank in m³. (14). the capacitance/capacity (is working) of tank in m³. (15). the number of interdepartmental standard. (16). length. (17). width. (18). height/altitude. (19). Location of substation. (20). Closed. (21). Semienclosed. (22). Closed. (23). or.

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DESIGNER'S HANDBOOK - INSTALLING THERMAL PIPE-LINE SYSTEMS. PAR--ETC(U)

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Table 17.5. Characteristics and approximate size/dimensions of condensate pumping substations with the coolants of condensate (for the closed locations).

(1) Количество откачиваемого конденсата в т/ч	(2) Подогреватели (охладители конденсата)		(3) Размеры помещений в м		
	(4) суммарная поверхность в м²	(5) номер междуведомственной нормали	(6) длина	(7) ширина	(8) высота
(9) До 5	4,54	1436-01	7	6	3,5
» 10	7,18	1436-02	8	5	3,8
» 25	19,9	1435-05	9	6	4,2
» 50	30,6	1436-06	9	9	4,7
» 100	30,6×2	1435-05	12	12	5
» 200	62,3×2	1437-06	18	12	5,5

Notes: 1. The types of preheaters are determined from the condition of cooling the condensate on 50-60°C.

2. Pump performance, electric motors and condensate tanks are accepted according to Table 17.4.

Key: (1). Quantity of evacuated condensate in t/h. (2). Preneaters (coolants of condensate). (3). Size/dimensions of locations in m. (4). total surface in m². (5). the number between of the industrial standard. (6). length. (17). width. (8). height/altitude. (9). To.

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Necessary altitude difference is determined from the

formula

$$H > \frac{p_н + \Delta p_т + \Delta p_к - p}{\gamma_к} м, \qquad (17.3)$$

where $p_н$ is the saturation pressure, corresponding to the temperature of the pumped over condensate t_s, in kgf/m²; $\Delta p_т$ is an incidence/drop in the manifold pressure in kgf/m²; $\Delta p_к$ is a reserve of pressure for prevention of cavitation in kgf/m²; p - pressure above the level of condensate in tank in kgf/m²; $\gamma_к$ is specific weight of condensate in kG/m³.

Value $\Delta p_к$ is determined from the reserve of temperature for the prevention/warning of cavitation from the formula

$$\Delta p_к = p_к - p_н \text{ kgf/m}^2 \qquad (17.4)$$

where $p_к$ is the saturation pressure, corresponding to the temperature t'_s, in kgf/m².

Temperature t'_s can be determined by the formula

$$t'_s = t_s + \Delta t_к \,°C. \qquad (17.5)$$

Value $\Delta t_к$ is recommended to accept equal to 2-3°C.

Example. On assigned/prescribed $t_s = 104°$ C, $p_н = p = 2000$ kgf/m² (neq) kgf/m², $\Delta t_к = 2°$ C and $\Delta p_к = 2800 - 2000 = 800$ kgf/m² we determine

$$H > \frac{2000 + 200 + 800 - 2000}{900} = 1.04 \text{ м} \approx 1 \text{ m}.$$

Pumping of the pressure-reducing and cooling

installations (ROU) are intended for the supply of the chemically purified water or condensate to the nozzles of damping installation.

Figures 17.6 gives the circuit of pumping for ROU with pressure 20/10 atm(abs.). In pumping are installed, as a rule, two pumps, of which one is standby. Each pump is selected according to the maximum hourly consumption of cooling water. The pump head is determined of the condition of providing the pressure at the point of supply on 10 kg/cm^2 higher than pressure pair.

Drainage pumping are intended for the evacuation of underground water from system of the incidental drainage of the underground packing of thermal networks, of the buildings of pumping and preheating.

The number of pumps in these pumping is accepted not less than two, of which one standby.

The efficiency of workman pump is accepted equal to the maximum hour water inflow, value of which is determined according to the indications of Chapter 15.

With the excess of inflow over maximum design capacity, a quantity of evacuated drainage water can be increased because of the launching/starting of standby pump.

Table 17.6. Characteristic and the exemplary/approximate size/dimensions of drainage pumping according to data of VGPI Electroheat-plan.

(1) Наименование и место размещения дренажной насосной	(2) Насосы (2 шт.)		(3) Электродвигатели (2 шт.)			(4) Вес насоса и электродвигателя с плитой в кг	(5) Размеры насосных в м		
	(6) тип	(7) производительность каждого насоса в м³/ч	(8) напор в м вод. ст.	(6) тип	(9) мощность каждого электродвигателя в квт	(10) число оборотов в мин		(11) длина	(12) ширина	(13) высота
(14) Подземная насосная рядом с камерой или тоннелем (одноэтажная)	2К-6а	10—30	28—20	А-42-2	4,5	3000	80,7	3	2,5	3,5
(15) Надземная насосная рядом с камерой или тоннелем (двухэтажная)	3К-9а	25—45	24,2—19,5	А-42-2	4,5	3000	97,7	5,9	2,5	5,1

Key: (1). Designation and the place of arrangement/position by drainage pumping. (2). Pumps (2 pcs.). (3). Electric motors (2 pcs.). (4). Weight have sucked and electric motor with plate/slab in kg. (5). Size/dimensions of pumping in m. (6). type. (7). the capacity of each pump in m³/h. (8). pressure in m water column. (9). the power of each electric motor in kW. (10). speed in min. (11). length. (12). width. (13). height/altitude. (14). Underground is pumping next to the camera/chamber or the tunnel (single-stage). (15). Above-grade is pumping next to the camera/chamber or the tunnel (two-story).

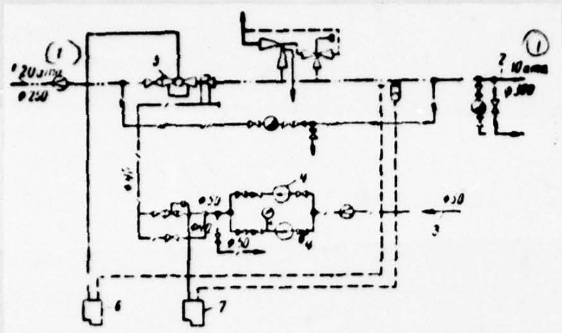

Fig.17.6

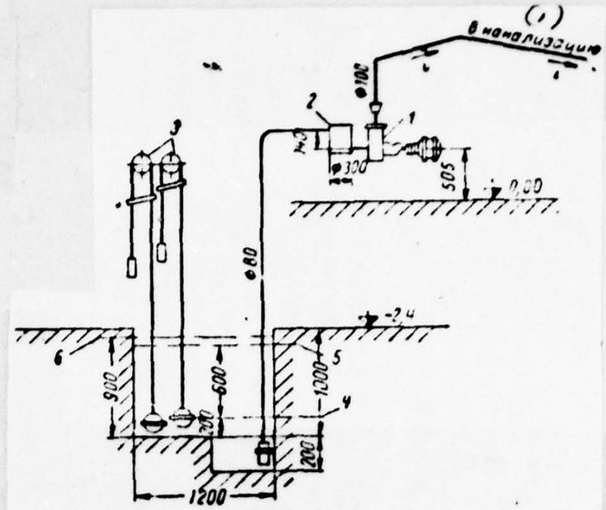

Fig.17.7

Fig. 17.6. Circuit of pumping for pressure-reducing and cooling setting up in shop 1 - steam line of throttled vapor; 2 - steam line of throttled steam; 3 - softened water or condensate; 4 - pumps; 5 - throttle valve; 6 - column of pressure adjustment; 7 - column of temperature control.

Key: (1). atm(abs.).

Fig. 17.7. Circuit of drainage pumping for drainage of locations 1 - pump; 2 - small tank for bay/molded edge of pump; 3 - float relays; 4 and 5 - levels of disconnection and start of drainage pump respectively; 6 - level of

signaling about noninclusion of drainage pump.

Key: (1). In channelization.

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Indoor by drainage pumping is arranged the pit by capacitance/capacity not less than 30o/o of maximum hour entrance of ground water.

The practice of the planning of drainage pumping heat-input of the networks of a series of cities showed that productivity these pumping with well filtering soils composes 200-250 m^3/h, and with dense soils 20-60 m^3/h. The head of drainage pumps as as rule oscillates within limits 20-25 m water column.

Figures 17.7 shows the circuit of drainage pump for the drainage of locations, while in Fig. 17.8 - a circuit by drainage pumping on network for drainage from the system of incidental drainage.

Drainage pumping for pumpage from buildings are designed

for the entrance of the random water through the leakage/looseness of the moisture-proof protection of the underground part of buildings and leakage/looseness of fittings and equipment. For these pumping is allow/assumed the setting up of one pump without reserve.

Productivity such pumping usually composes 10-20 m^3/h, and pressure - 20-30 m water column.

Characteristic and exemplary/approximate size/dimensions drainage pumping for thermal networks are given in Table 17.6.

17.2. Equipment of pumping installations.

Pumps and electric motors to them.

The power of the adjustable pumps can be determined by the formula

$$N = \frac{VH\gamma}{367\,000\,\eta_{э.д}\eta_{н}} \text{ KW} \qquad (17.6)$$

where V is a pump capacity in m^3/h; H - the pump head in m of water. st.; γ is the specific gravity/weight of

water; $\eta_{эд}$ and $\eta_{н}$ - the efficiency of electric motor and pump.

The speed of pumps cannot be increased without agreement with manufacturing plant.

Is allow/assumed the work of pumps with the lowered/reduced speed, in this case the conversion is produced according to the equation

$$\frac{n_1}{n_2} = \frac{V_1}{V_2} = \sqrt{\frac{H_1}{H_2}} = \sqrt[3]{\frac{N_1}{N_2}}. \qquad (17.7)$$

Power of electric motors, as a rule, is assigned by plant - the producer of pumps.

In the absence of plant data, the power of electric motors is determined from the formula

$$N_{э} = rN \text{ kW} \qquad (17.8)$$

where N is lifting power, determined by formula (17.6); r - numerical coefficient, taken at the power of pumps up to 50 kW equal to 1.2-1.3, but above 50 kW - equal to 1.1-1.2.

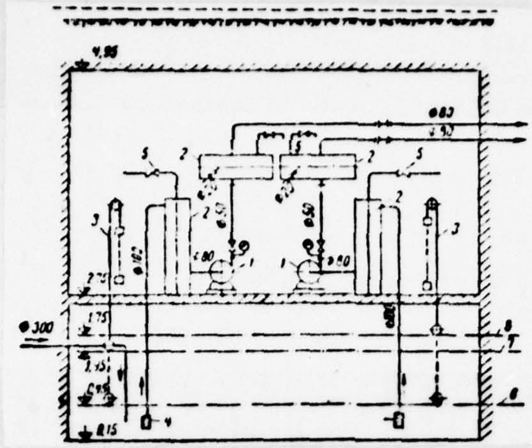

Fig. 17.8. Circuit of drainage pumping for drainage from system of incidental drainage 1 - pumps; 2 - small tanks for bay/molded edge; 3 float relays; 4 - suction valves with grid; 5 - valve/gates (upon start of pumps automatically are closed); 6 - level of disconnection of pumps, 7 - level of start of I pump; 8 - level of start of II pump.

Table 17.7. Technical characteristic of network pumps for setting up on hot water with temperature to 180°C.

(1) Марка насоса	(2) Подача в $м^3/ч$	(3) Напор в м вод. ст	(4) К. п. д. в %	(5) Подпор сверх упругости паров в м вод. ст.	(6) Число оборотов в мин	(7) Температура в °C
10СД-6	490	67,5	76,5	4	1450	Д . 180
12СД-10×2 (12СД-6)	790	90,2	77	5,5	1450	. 180
12СД-9	790	60	77	5,5	1450	. 150
14СД-10×2 (14СД-6)•	1260	123	77	7,5	1490	. 180

Note. Data on the indicated mark/brands of pumps are given on plant tests or on projects.

(1). Mark/brand of pump. (2). Supply in m^3/h. (3). Pressure in m water column. (4). Efficiency into o/o. (5). Backwater over the vapor pressure in m water column. (6). Speed in min. (7). Temperature in °C.

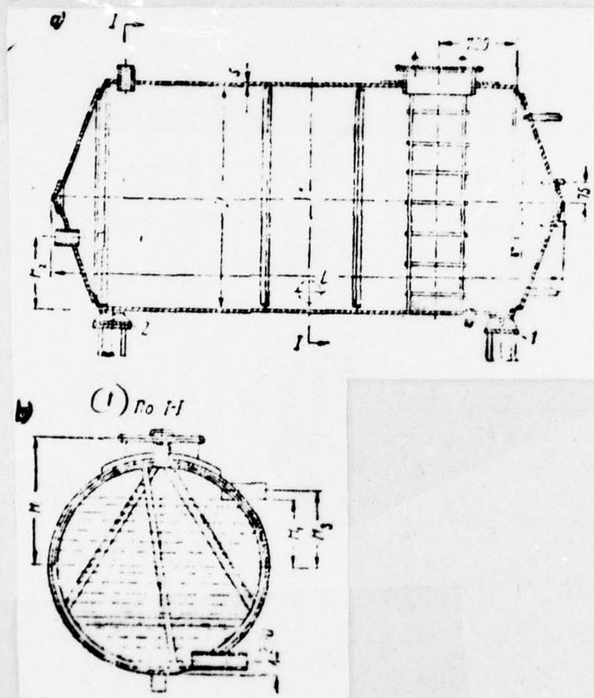

Fig. 17.9. Condensate tank with conical bottom. a) general view; b) cut/section on 1-1; 1 - fixed support 2 is sliding base.

Key: (1). On.

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Table 17.8. Overall dimensions of pumps of the type SD with electric motors on one base plate.

(1) Марка насоса	(2) Размеры в мм											
	А	Б	В	Г	Е	Ж	З	И	К	Л	М	Н
12СД-9	2795	1480	755	1310	80	1000	565	80	950	2655	660	450
10СД-6	2780	1470	765	1310	80	1000	560	80	950	2650	660	450
12СД-10×2	3397	2182	743	1215	80	1600	580	80	880	3300	1260	480
14СД-10×2	3569	2507	1062	1877	80	1880	659/684	80	1420/1376	4199	1540	1020/970

(1) Марка насоса	(2) Размеры в мм								(3) Условный диаметр патрубков в мм		(4) Тип электродвигателя
	X	X_1	Ц	$Ц_1$	Ч	Щ	Ю	Я	D	D_1	
12СД-9	160	180	660	400	615	—	—	900	300	300	А-103-4
10СД-6	160	180	660	400	645	—	—	900	250	150	А-102-4
12СД-10×2	180	200	680	500	1155	635	560	900	300	250	А-112-4
14СД-10×2	180	190	800	630/560	1440	—	—	900	350	300	ДАМСО 157-4 / ДАМСО 1410-4

Note. The general view of pumps 10SD-6 is similar to the general view of pumps 12SD-9, while the general view of pumps 14SD-10 x 2 - with the general view of pumps 12SD-10 x 2.

Key: (1). Mark/brand of pump. (2). Dimensions in mm. (3). Conditional diameter of branch connections in mm. (4). Type of electric motor.

Table 17.9. Technical characteristics and the size/dimensions of condensate and deaerator tanks.

Table 17.9

(1) Наименование баков	(2) Емкость в $м^3$		(3) Основные размеры в мм		(4) Дополнительные габаритные размеры в мм					(5) Вес в кг	(6) Номер междуведомственной нормали
	(7) рабочая	(8) геометрическая	(9) диаметр D	(10) длина L	H	S	H_1	H_2	H_0		
(11) Конденсатные с коническими днищами	2	2,45		2 050					495	607	2102-01
			1400		820	4	420	500			
	4	4,6		3 450					525	834	2102-02
	6	7,23		3 000						1280	2102-03
	8	9,26	2000	3 700	1145	4	600	650	705	1419	2102-04
	10	11,5		4 400						1585	2102-05
	15	15,8	2600	3 950	1453	6	780	800	885	2310	2102-06
(12) То же, с эллиптическими днищами	10	12	2000	4 190	1145	4	600	650	705	1477	2107-01
	15	17,7	2600	3 790	1458	6	780	800	885	2333	2107-02
(13) То же, с цилиндрическими днищами	4	4,62	1400	3 208	820	4	420	500	525	735	2120-01
	8	9,11	2000	3 208	1145	4	600	650	705	1071	2120-02
	10	11,3		3 908						1211	2120-03
	25	28,8	2600	6 210	1450	8	800	1400	155	4226	746-01
											746-02
(14) Деаэраторные с коническими днищами (p=1,3 *ата*)	35	40,1	2600	8 370	1450	8	800	1600	155	5340	746-03
										5338	746-06
	50	57,9	3200	8 165	1750	8	1000	1650	360	6736	746-07
										6727	746-10
	75	86,5	3200	11 715	1750	8	1000	3250	360	9185	746-11
										9176	746-14
(15) То же, с выпуклыми днищами (p=1,3 *ата*)	25	28,7	2600	5 870	1450	8	800	1400	155	3868	775-01
											775-02
	35	40,4	2600	8 070	1450	8	800	1600	155	5172	775-03
											775-04
										5170	775-05
											775-06
										6131	775-07
											775-08
	50	57,2	3200	7 670	1750	8	1000	1650	360		
											775-09
										6122	775-10
	75	86,1	3200	11 270	1750	8	1000	3250	360	8612	775-11
											775-12
											775-13
										8602	775-14

Key: (1). Designation of tanks. (2). Capacitance/capacity in m^3. (3). Basic dimensions in mm. (4). Additional overall dimensions in mm. (5). Weight in kg. (6). Number of interdepartmental standard. (7). working. (8). geometric. (9). diameter. (10). length. (11). Condensate with conical bottoms. (12). The same, with elliptical by bottoms. (13). The same, with cylindrical by bottoms. (14). Deaerating with conical bottoms (p = 1.3 atm(abs.)). (15). The same, with the dished bottoms (p = 1.3 atm(abs.)).

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Table 17.10. Technical characteristics and the size/dimensions of expansion tanks.

(1) Геометрический объем в $м^3$	(2) Рекомендуемые типы подстанций	(3) Номер междуведомственной нормали	(4) Размеры в мм									(5) Вес в кг
			$D_н$	H	H_1	H_2	d	d_1	d_2	d_3	d_4	
0,125	I	2091-01	426	1000	600	400	108	57	57	89	15	93,6
0,25	I и II	2091-02	529	1200	700	500	133		89	133	18	145
0,5	III	2091-03	630	1700	1100	700	159	89	108	159		257
0,75	III и IV	2091-04	820	1500	900	650	219		133	219		453
1	IV, V и VI	2091-05		2000	1300	1000	273					593

Key: (1). Geometric volume in m^3. (2). Recommended types of substations. (3). Number of the interdepartmental standard. (4). Size/dimensions in mm. (5). Weight in kg.

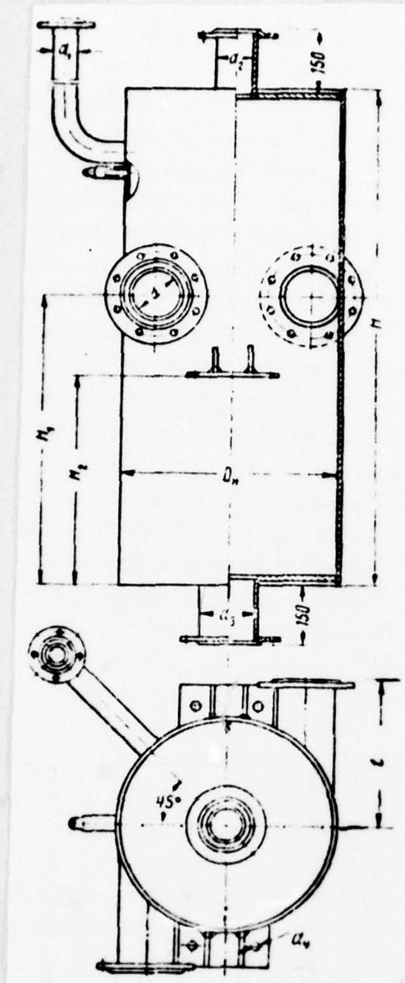

Fig. 17.10. General view of expansion tank.

Fig. 17.11. Circuit of hydraulic safety device for closed condensate substations 1 - condensate tank; 2 - tube for steam exhaust and overflow of condensate.

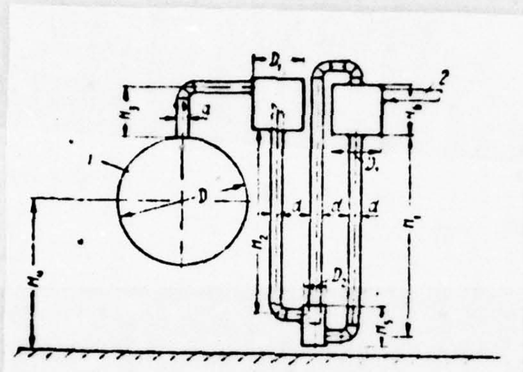

Fig. 17.11

Table 17.11. Size/dimensions of safety water locks on condensate tanks for the closed systems of the collection of condensate.

(1) Тип на-сосных	(2) Диаметр бака D в мм	(3) Размеры в мм								
		d	D_1	D_2	H_1	H_2	H_3	H_4	H_5	H_6
I	1000	80	350	150	2000	2000	750	1500	330	400
II	1400	100	450	200	2200	1900	400	1700	390	500
III	1400	125	500	200	2200	1800	400	1700	420	550
IV	2000	150	600	250	2400	2200	400	2000	470	650
V	2600	200	700	300	2400	2600	400	2300	570	750
VI	2600	250	800	400	2400	2400	400	2300	670	850

Note. The selection of the diameter of water lock d is produced from mounting conditions for one water lock for pumping I, II and III types and two water locks for the pumping IV, V and VI of types.

Key: (1). Type of pumping. (2). Diameter of tank D in mm. (3). Size/dimensions in mm.

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The size/dimensions of pumps of the type SD are given in Table 17.8.

Tanks. For condensate, expansion and deaerating tanks by the Leningrad branch of Orgenergostroya are developed interdepartmental standards (MVN). Volume and the basic dimensions of condensate and expansion tanks on MVN are given in Table 17.9 and 17.10, but general views of tanks - in Fig. 17.9 and 17.10.

The real volume of condensate tank on MVN is selected of the calculation of filling by its condensate not more than 80o/o of its altitude or diameter, which corresponds

to the solidity/loading factor of tank of approximately 0.86.

The branch of tanks are provided for without flanges taking into account their connection with tubes and fittings by butt welding. The wall thickness of branches is designed to flat/plane welded flanges. Branch on tank they are establish/installed according to projects.

Condensate tanks are installed on supporting beams, arrange/located across the longitudinal axis of tank.

Supports is recommended the placing of symmetrically with the distance between them about 0.5-0.55 from the length of tank.

The volume of expansion tanks $V_б$ is recommended to determine from calculation 1 m³ of tank for 2000 m³/h separated vapor according to the formula

$$V_б = 0,5 vxG \text{ м}^3, \quad (17.9)$$

where v - specific volume is pair in m³/kg; G - the consumption of condensate in t/h; x is a weight steam content of condensate in the portions of one.

The volume of water space in expansion tanks is recommended to take as equal to 20o/o of the steam tank volume.

Operating pressure for tanks on MVN is taken as for condensate and expansion equal to 0.5 atm(gage) a for deaerating - 0.3 atm(gage).

For the closed systems of the collection of condensate on condensate tanks or near them on wall are establish/installed hydraulic safety device/fuse-water locks.

The circuit of water lock is shown in Fig. 17.11, and overall dimensions for different types condensate pumping, indicated Table 17.4 and 17.5, gives in Table 17.11.

The diameter of tubes d of water lock they are determined a the conditions of the free drain of condensate for the formula

$$d = 0{,}025\sqrt{G}\ м, \qquad (11.10)$$

where G is a quantity of the condensate returned in t/h.

For sizing of small tanks under condition $D_1 = H$,

$$D_1 = \sqrt[3]{nH_1 d^2}\ м, \qquad (11.11)$$

where n is the coefficient which considers an increase in the capacitance of small tanks; are taken as equal to 3-4.

Chapter 18.

PREHEATING INSTALLATIONS.

18.1. Basic condition/positions.

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In the systems of heat supply, are erected central preheating installations of sources of heat (heat and power plant, GRES [ГРЭС - state regional electric power plant], boiler, etc.), intermediate - in thermal grid/network and local - in thermal users.

Preheating installations are intended for the preheating of network, feed, tap water in the local and district systems of hot water supply, for cooling the condensate.

Depending on the primary (heating) heat carrier of installation, they are subdivided into steam-water, where the heating medium it is pairs, and water-to-water, where the heating medium is water.

On Figs. 18.1 and 18.2, are given the diagrams of steam-water and water-to-water preheating installations.

The technical characteristics of high-speed/velocity steam-water and water-to-water vertical and horizontal surface preheaters are given in Tables ~~their~~ 18.1-18.8, and general views to Figs. 18.3-18.5.

Table 18.1. Steam-water vertical preheaters of network water.

(1) Показатели	(2) Тип подогревателя БП-300-2М	БО-200М	БП-200	БП-200У	БО-350-2	БО-130М	БО-90М	БП-90М	БП-65М	БП-43М
(3) Поверхность нагрева в $м^2$	300	200	200	200	350	130	90	90	65	43
(4) Расчетный расход воды в $м^3/ч$	1100	335	1000	1000	1000	250	160	500	320	100
(5) Рабочее давление в *ати*:										
(6) парового пространства	14	15	7	13	0,7—2,5	1,5/5	1,5/8	6/8	5/8	7
(7) водяного »	14	14	14	14	15	14	14	14	14	12
(8) Пробное давление в *ати*:										
(6) парового пространства	14,5	2,5	10	16,5	2,5	8	11	11	11	10
(7) водяного »	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	15
(9) Температура среды в °С:										
(6) парового пространства	350	150	250	350	133	175	175	250	250	164
(7) водяного »	170	120	135	150	116	110	110	130	130	120
(10) Сечение для прохода воды в $м^2$	0,137	0,0615	0,123	0,123	0,158	0,042	0,029	0,058	0,043	0,0145
(11) Число ходов воды	2	4	2	2	2	4	4	2	2	4
(12) » трубок	1143	1018	1018	1018	1320	708	488	488	360	236
(13) Диаметр корпуса в *мм*	1540	1228	1228	1212	1520	1020	920	920	820	720
(14) Общая высота подогревателя в *мм*	6160	5390	5575	5586	6655	4800	4570	4646	4624	4044
(15) Сопротивление водяной части в *м вод. ст.*	5	4,4	4,5	4,5	4,5	3,8	2,8	3,4	2,5	6,5
(16) Вес в *т*:										
(17) без воды	10	5,3	5,6	6,6	8,1	3,2	2,8	2,9	2,1	1,6
(18) с водой	11,5/19,4	7,39/8,9	7,53/9,1	8,2/11,5	—/17,8	—/6,6	—/4,1	—/4,2	3,05/3,6	2,1/3,9
(19) Длина пути конденсата вдоль поверхности теплообмена до промежуточной горизонтальной перегородки в *м*	1,59	1,72	1,72	1	—	—	—	—	—	1,47

Notes: 1. The material of tubes is brass, diameter of the tubes 17.5/19 mm.

2. In numerator weight of preheater is given taking into account water in tube bank, in denominator taking into account complete filling with water of preheater.

Key: (1). Indices. (2). Type of preheater. (3). Heating surface in m². (4). Calculated consumption of water in

m^3/h. (5). Operating pressure in atm(gage). (6). steam space. (7). water space. (8). Test pressure in atm(gage). (9). Temperature of medium in °C. (10). Section/cut for the pass of water in m^2. (11). Number of courses of water. (12). Number of tubes. (13). Diameter of housing in mm. (14). The overall height of preheater in mm. (15). Resistance to water section in m water column. (16). Weight in t. (17). without water. (18). with water. (19). Path length of condensate along transfer surface up to intermediate horizontal partition/baffle in m.

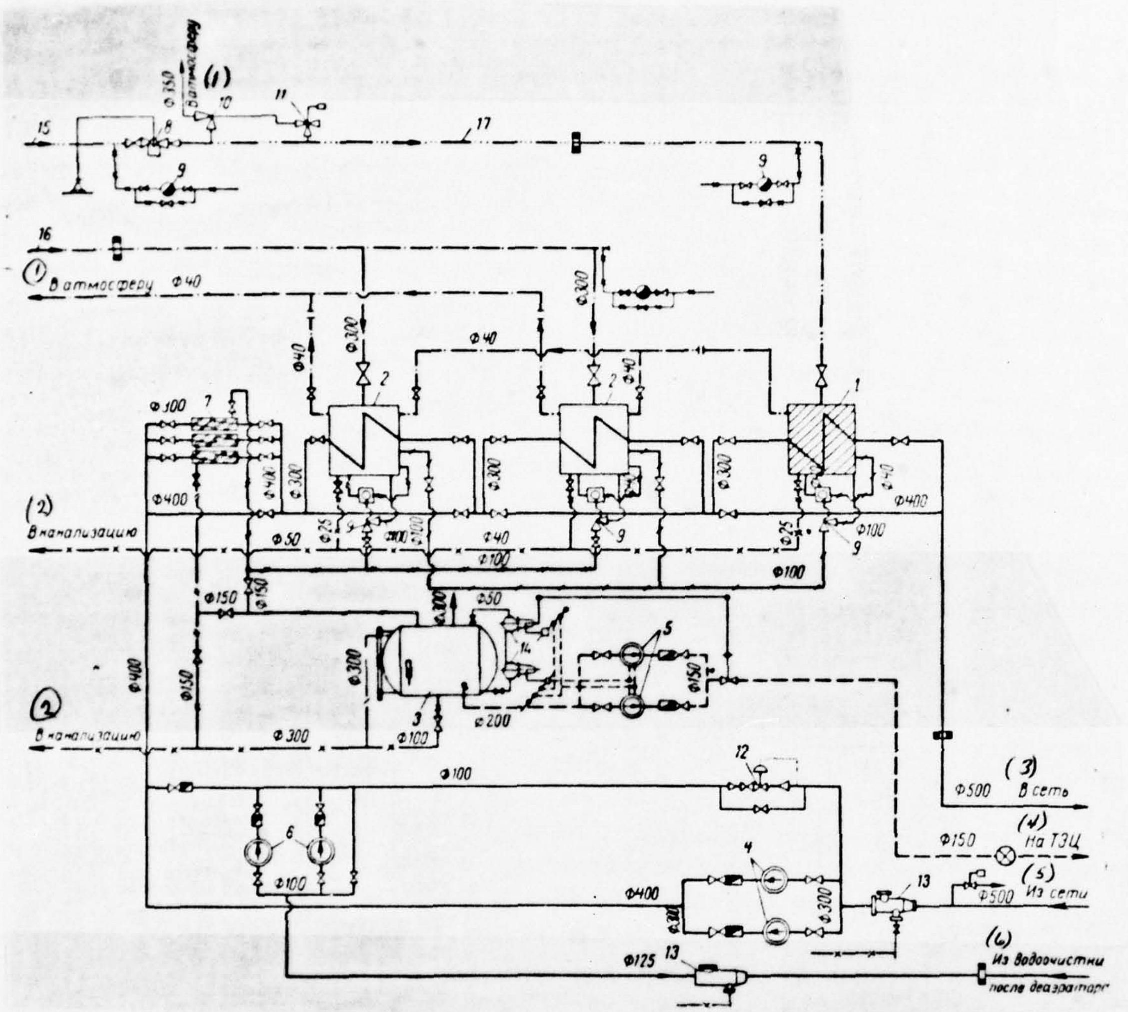

Fig. 18.1. Diagram of steam-water preheating installation on 50-60 gcal/h with use the pair of two parameters. 1 - preheater peak; 2 - preheater of basic; 3 - tank for a condensate; 4 - network pump; 5 - condensate pump; 6 - makeup pump; 7 - coolant of condensate; 8 - reduction installation; 9 - condensate branch; 10 - emergency safety valve; 11 - pulse valve; 12 - control valve; 13 - sludge pans; 14 - float relay; 15 - steam line 20 atm(abs.); 16 - steam line 2.5 atm(abs.); 17 - steam line 8 atm(abs.).

Key: (1). In the atmosphere. (2). In channelization. (3). In grid/network. (4). On heat and power plant. (5). From grid/network. (6). From water purification after deaerator.

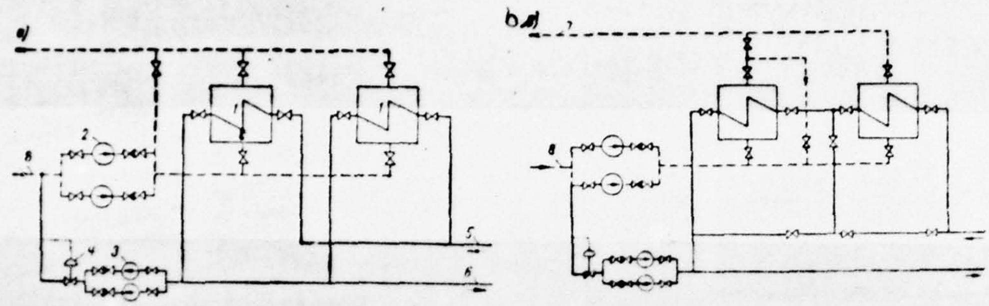

Fig. 18.2. Diagram of water-to-water sectionalizing preheatin installation. a) with the parallel-connected preheaters; b) with the series-connected preheaters; 1 - preheaters; 2 - network pumps; 3 - makeup pumps; 4 - pressure regulator; - delivery pipe; 6 - return line of the heating water; 7 - delivery pipe; 8 - return line of the heated water.

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Table 18.2. Coolants of condensate OG (horizontal), OV (vertical).

(1) Тип охладителя	(2) Поверхность нагрева в $м^2$	(3) Производительность расчетная в т/ч	(4) Диаметр корпуса в мм	(5) Длина в мм	(6) Количество корпусов и трубок в шт.	(7) Рабочее давление в $кгс/см^2$		(8) Рабочая температура в °C		(9) Вес в т	(10) Примечание
						(11) в корпусе	(12) в трубном пучке	(11) в корпусе	(12) в трубном пучке		
ОГ-6	6	98	273	2328	1/56	4	4	100	130	0,43	(13) Один ход
ОГ-12-1А	12	98	273	2000	2/56	4	13	130	100	0,74	(14) Всего 4 хода
ОГ-24	24	182	273	2000	4/56	4	13	150	140	1,45	8 ходов (15)
ОГ-32	32	335	426	3904	1/36	10	2,5	24	104	1,3	8 »
ОГ-35	35	45	325	2170	4/164	13	13	90	130	2,04	8 »
ОГ-130	130	110	426	4310	4/162	2,5	10	80	70	5,6	8 »
ОВ-140	140	—	846	—	—	3	23/25	45/40,9	37/35	3,85	2 хода (15)
ОВ-40	40	—	672	4487	1/92	1,5/1,18	23/25	125/119,8	100/105	2,39	2 »
ОГ-24-1н	24	9,6/17	273	1994	4/56	4	6	35/52	70/40	1,33	(14) Всего 8 ходов
ОГ-130-1М	130	90/144	426	4270	4/162	4	6	35/60	80/40	4,24	8 »

Notes: The tubes steel 22 x 2 mm.

2. In graph/count of productivity into numerator e, is given quantity of water of core circuit (in tube bank), in denominator - quantity of water of secondary outline/contour (in intertube space); in graph/count of temperatures in numerator, is given temperature of entering water, in denominator - temperature of coming out water.

Key: (1). Type of coolant. (2). Heating surface in m^2. (3). Productivity calculated in t/h. (4). Diameter of housing in mm. (5). Length in mm. (6). Quantity of housings and tubes in pcs. (7). Operating pressure in kg/cm^2. (8). Operating temperature in °C. (9). Weight in t. (10). Note. (11). in housing. (12). in tube bank. (13). One Course. (14). Entire ... course. (15). courses.

Table 18.3. Steam-water preheaters of thermal grid/networks.

(1) Показатели	(2) Подогреватели короткие по МВН 1436—58						(3) Подогреватели длинные по МВН 1437—58					
	(4) двухходовые		(5) четырехходовые				(4) двухходовые		(5) четырехходовые			
	1436-01	1436-02	1436-03	1436-04	1436-05	1436-06	1437-01	1437-02	1437-03	1437-04	1437-05	1437-06
(6) Поверхность нагрева в $м^2$	4,54	7,18	8,09	9,39	19,9	30,6	9,15	14,5	16,35	19	40,5	62,3
(7) Наружный диаметр корпуса $D_н$ в мм	273	325	377	426	529	630	273	325	378	426	529	630
(8) Условный проход штуцера для входа и выхода воды $d_{н2}$ в мм	76	89	76	76	108	133	76	89	76	76	108	133
(9) Условный проход штуцера для пара $d_н$ в мм	89	108	108	133	159	219	89	108	108	133	159	219
(10) Условный проход штуцера для выхода конденсата $d_{н1}$ в мм	76	76	76	89	108	159	76	76	76	89	108	159
(11) Длина трубок в мм	2040	2040	2040	2040	2040	2040	4080	4080	4080	4080	4080	4080
(12) » корпуса L в мм	2515	2562	2566	2568	2625	2705	4555	4602	4606	4608	4666	4745
(13) Площадь сечения в $м^2$:												
(14) межтрубного пространства	0,042	0,06	0,083	0,113	0,169	0,223	0,042	0,06	0,083	0,113	0,169	0,223
(15) всех трубок	0,01	0,015	0,017	0,02	0,041	0,066	0,01	0,015	0,017	0,02	0,041	0,066
(16) трубок одного хода	0,005	0,0075	0,0042	0,005	0,0102	0,0165	0,005	0,0075	0,0042	0,005	0,0102	0,0165
(17) Общее количество трубок в шт.	48	76	86	100	214	330	48	76	86	100	214	330
(18) Максимальное количество трубок в вертикальном ряду в шт.	4	6	6	6	10	10	4	6	6	6	10	10
(19) Вес без воды в кг	299	380	523	571	920	1344	447	573	781	803	1285	1839

Key: (1). Indices. (2). Preheaters short on MVN 1436-58. (3). Preheaters long on MVN 1437-58. (4). two-pass. (5). fourway. (6). Heating surface in m². (7). Outside diameter of housing D_H in mm. (8). The internal diameter of branch for entry and yield of water d_{H2} in mm. (9). The internal diameter of branch for pair d_H in mm. (10). The internal diameter of branch for the yield of condensate d_{H1} in mm. (11). Length of tubes in mm. (12). Length of housing L in mm. (13). Cross-sectional area in m². (14). intertube space (15). all tubes. (16). the tubes of one course. (17). Total quantity of tubes in pcs. (18). Maximum quantity of tubes in a vertical series in pcs. (19). Weight without water in kg.

Table 18.4. Limits of the application/use of steam-water preheaters on MVN 1436-58 and MVN.

(1) Наименование	(2) Условное давление в $кгс/см^2$	(3) Рабочее давление при температуре среды в °C					
		до 200	250	300	350	400	425
(4) Паровое пространство	10	10	9,2	8,2	7,3	6,4	5,8
(5) Водяное пространство	16	—	—	—	—	—	—

Note. Tubes brass by diameter 16 x 14 mm.

Key: (1). Designation. (2). Conditional pressure in kg/cm^2. (3). Operating pressure at the temperature of medium in °C (4). Steam space. (5). Water space.

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Table 18.5. Water-to-water preheaters of thermal grid/network for a heating.

(1) Показатели	(2) Тип (марка) подогревателя по МВН 2050—62 (взамен 2050—57)							
	$2050-\frac{29}{2}$	$2050-\frac{30}{2}$	$2050-\frac{31}{2}$	$2050-\frac{32}{2}$	$2050-\frac{33}{7}$	$2050-\frac{34}{2}$	$2050-\frac{35}{7}$	$2050-\frac{36}{7}$
(3) Поверхность нагрева в $м^2$	3,38	6,84	6,33	12,75	9,93	20,13	13,73	27,86
(4) Наружный диаметр корпуса $D_н$ в мм	168	168	219	219	273	273	325	325
(5) Входной и выходной штуцеры в трубное пространство $d_{н1}$ в мм	114	114	168	168	219	219	219	219
(6) Входной и выходной штуцеры в межтрубное пространство $d_н$ в мм	133	133	168	168	219	219	273	273
(7) Длина секции трубок L в мм	2040	4080	2040	4080	2040	4080	2040	4080
(8) Длина корпуса подогревателя с одной секцией L_1 в мм	2322	4362	2402	4442	2422	4462	2492	4532
(9) Длина корпуса подогревателя с двумя секциями L_2 в мм	2502	4542	2640	4680	2729	4769	2840	4880
(10) Длина корпуса подогревателя с тремя секциями L_3 в мм	2682	4722	2877	4917	3035	5075	3187	5227
(11) Площадь сечения трубок в $м^2$	0,00507	0,00507	0,00935	0,00935	0,0147	0,0147	0,0204	0,0204
(12) Площадь межтрубного пространства в $м^2$	0,0122	0,0122	0,0198	0,0198	0,0308	0,0308	0,0446	0,0446
(13) Количество трубок в одной секции в шт.	37	37	69	69	109	109	151	151
(14) Вес без воды одной секции в кг	147	225	228	363	333	613	448	733
(15) То же, двух секций в кг	271	425	427	702	635	974	865	1432

Note. Tubes steel by diameter 16 x 1.4 mm.

Key: (1). Indices. (2). Type (mark/brand) of preheater on MVN 2050-62 (instead of 2050-57). (3). Heating surface in m^2. (4). Outside diameter of housing D_H in mm. (5). Intake and output branches into tube space d_{H1} in mm. (6). Intake and output if connecting pipes into intertube space d_H in mm. (7). Length of the section of tubes L in mm. (8). Length of the housing of preheater with one section L_1 in mm. (9). Length of the housing of preheater with two sections L_2 in mm. (10). Length of the housing of

preheater with three sections L_3 in mm. (11). Cross-sectional area of tubes in m^2. (12). Area of intertube space in m^2. (13). Quantity of tubes in one section and pcs. (14). Weight without water of one section in kg. (15). The same, two sections in kg.

Table 18.6. Water-to-water preheaters of thermal networks fo hot water supply without line.

(1) Показатели	(2) Тип подогревателя															
	2052-21	2052-22	2052-23	2052-24	2052-25	2052-26	2052-27	2052-28	2052-29	2052-30	2052-31	2052-32	2052-33	2052-34	2052-35	2052-36
(3) Поверхность нагрева в $м^2$	0,38	0,77	0,67	1,35	1,15	2,32	1,8	3,66	3,53	7,14	6,58	13,3	10,4	21	14,3	29,1
(4) Наружный диаметр корпуса $D_н$ в мм	57	57	70	70	89	89	114	114	168	168	219	219	273	273	325	325
(5) Входной и выходной штуцеры в трубное пространство $d_{н1}$ в мм	45	45	57	57	70	70	89	89	114	114	168	168	219	219	219	219
(6) Входной и выходной штуцеры в межтрубное пространство $d_н$ в мм	45	45	57	57	70	70	89	89	133	133	168	168	219	219	273	273
(7) Длина секции L в мм	2040	4080	2040	4080	2040	4080	2040	4080	2040	4080	2040	4080	2040	4080	2040	4080
(8) Длина корпуса подогревателя с одной секцией L_1 в мм	2322	4362	2322	4362	2322	4362	2322	4362	2322	4362	2402	4412	2422	4462	2492	4532
(9) Длина корпуса подогревателя с двумя секциями L_2 в мм	2346	4386	2373	4413	2392	4432	2425	4465	2502	4542	2640	4680	2728	4768	2840	4880
(10) Длина корпуса подогревателя с тремя секциями L_3 в мм	2369	4409	2424	4464	2463	4503	2528	4568	2682	4722	2877	4917	3035	5075	3187	5227
(11) Площадь сечения трубок в $м^2$	0,00066	0,00066	0,00116	0,00116	0,00198	0,00198	0,00314	0,00314	0,00612	0,00612	0,0114	0,0114	0,018	0,018	0,025	0,025
(12) Площадь межтрубного пространства в $м^2$	0,00116	0,00116	0,00181	0,00181	0,00287	0,00287	0,005	0,005	0,0122	0,0122	0,0198	0,0198	0,0308	0,0308	0,0446	0,044
(13) Количество трубок в одной секции в шт.	4	4	7	7	12	12	19	19	37	37	69	69	109	109	151	151
(14) Вес без воды одной секции в кг	31	43	39	54	53	76	74	108	129	193	198	306	289	453	388	612
(15) То же, двух секций в кг	51	76	65	95	89	136	128	196	230	364	368	585	543	870	741	1189

Notes: 1. Tubes 16 x 0.75 of brass of brand L-62; from client's substantiated requirement the preheaters should also to be supplied with tubes from brass of brand L-68.

2. Preheaters temporarily are manufactured on fitting bays.

3. Preheated water should be passed on heat exchange tubes

Key: (1). Indices. (2). Type of preheater. (3). Heating surface in m^2. (4). Outside diameter of housing D_H in mm. (5). Intake and output branches into tube space d_{H1} in mm. (6). Intake and output branches into interpipe space d_H in mm. (7). Length of section L in mm. (8). Length of the housing of preheater with one section L_1 in mm. (9). Length of the housing of preheater with two sections L_2 in mm. (10). Length of the housing of preheater with three sections L_3 in mm. (11). Cross-sectional area of tubes in m^2. (12). Area of intertube space in m^2. (13). Quantity of tubes in one section in pcs. (14). Weight without water of one section in kg. (15). The same, two sections in kg.

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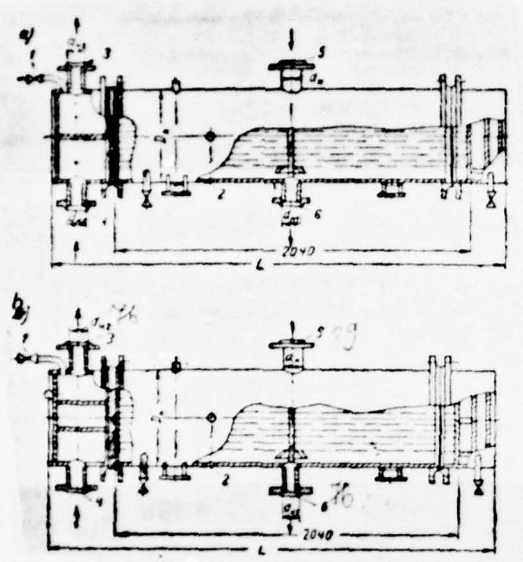

Fig. 18.3.

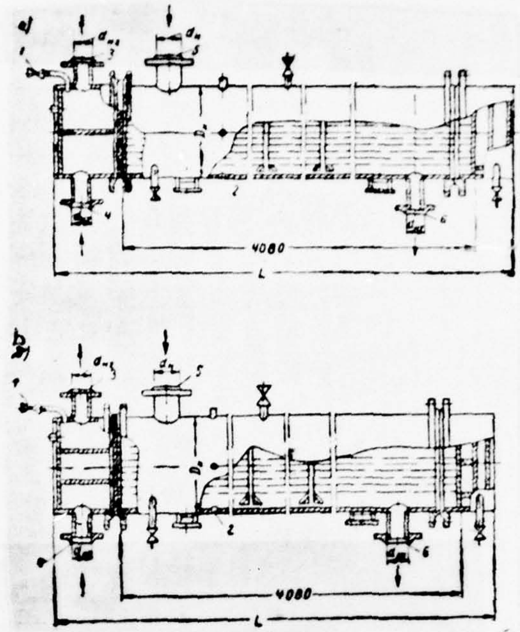

Fig. 18.4.

Fig. 18.3. Preheaters steam-water short (on MVN 1436-58). a) two-pass; b) fourway: 1 - air valve/gate; 2 - hole with by diameter 28 mm for connection to level gauge; 3 - yield of water; 4 - entry of water; 5 - entry is pair; 6 - yield of condensate.

Fig. 18.4. Preheaters steam-water long (on MVN 1437-58). a) two-pass; b) fourway; 1 - air valve/gate; 2 - hole by diameter 28 mm for connection to level gauge; 3 - yield of water; 4 - entry of water; 5 - entry is pair; 6 - yield of condensate.

Table 18.7. Limits of the application/use of water-to-water preheaters on MVN 2050-62 and 2052-62.

(1) Параметры среды	(2) Подогреватели по МВН	
	2050—62	2052—62
(3) Давление в межтрубном пространстве в *кгс/см²*	7	10
(4) Давление в теплообменных трубках в *кгс/см²*	10	10

Note. For the preheater, manufactured on MVN 2050-62, is recommended the chemically purified and deaerated water.

Key: (1). Parameters of medium. (2). Preheaters on MVN. (3). Pressure in intertube space in kg/cm². (4). Pressure in heat exchange tubes in kg/cm².

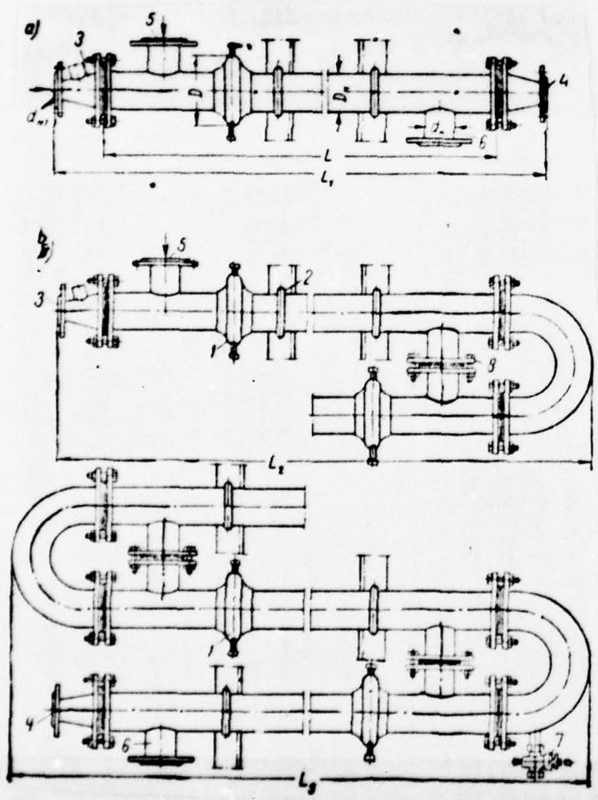

Fig. 18.5.

Fig. 18.5. Preheaters water-to-water (on MVN 2050-62 with lenses, on MVN 2050-62 without lenses). a) single-section; b) multisection; 1 - the expansion bellows; 2 - supports stationary and mobile; 3 and 4 - entry and the yield of water; 5 and 6 - entry and the yield of water; 7 - the tap/crane of drain; 8 - flange (is possible the replacement by welding).

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The general view of tape/film preheater is given on Fig. 18.6. Their fundamental design characteristics are given in Table 18.9.

On Figs. 18.7 and 18.8 Table 18.10 gives general views and the fundamental characteristics of the drainage controllers of large productivity to network preheaters from float and without float chambers. These drainage controllers work as level regulators.

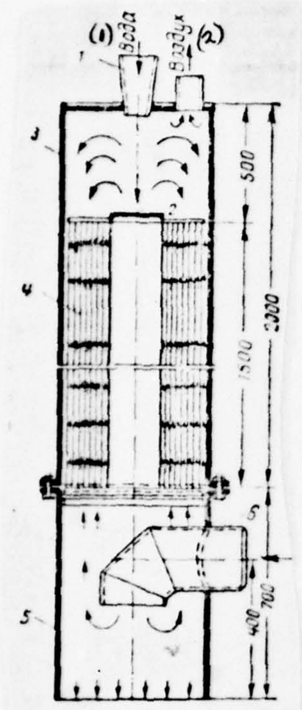

Fig. 18.6. Tape/film preheater. 1 - nozzle; 2 - baffle/socket; 3 - upper part of the body of preheater; 4 - concentric cylinders; 5 - lower part of the body; 6 - vapor pipe.

Key: (1). Water. (2). Air.

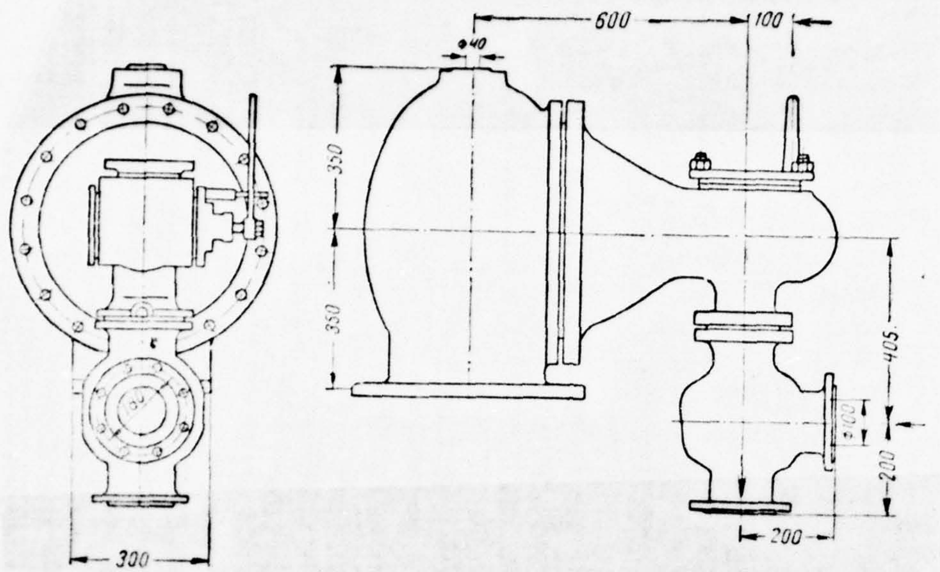

Fig. 18.7. Drainage controller LMZ of types KI10-150-II, K10-100-II, K16-100-II.

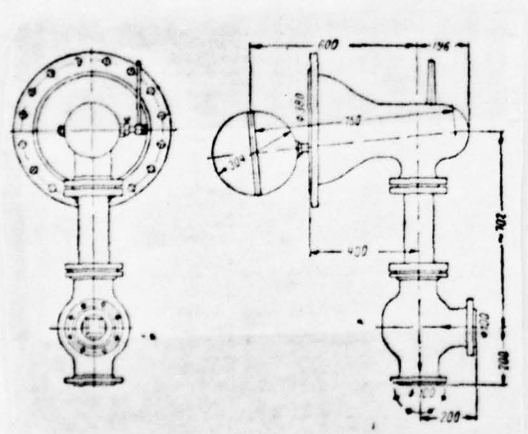

Fig. 18.8. Drainage controller LMZ of type KG2.5-100-I.

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Table 18.8. Steam-water and water-to-water high-speed/velocity preheaters of the construction of the Leningrad branch of Orgenergostroy, etc. (in addition to Table 18.3, 5, 6).

(1) Подогреватели	(2) Тип и номер	(3) Поверхность нагрева в $м^2$	(4) Размеры в мм		(5) Параметры $p_{пр}$ или $p_{раб}$ в $кгс/см^2$	(6) Материал трубок	
			(7) длина	(8) диаметр		(9) размеры в мм	(10) количество в шт.
(11) Пароводяные четырехходовые—длинные (ЦИТЛ)					(12) Давление пара $p_{пр}$=11; давление воды $p_{пр}$ = 20	(13) Стальные	
	МВН-400;	19	4612	426		16/14	100
	МВН-500;	40,5	4670	529			214
	МВН-600	62,3	4748	630			330
(15) Пароводяные четырехходовые — короткие (Оргэнергострой)					(13a) То же	(14) Латунные	
	МВН-400	9,39	2568	426		16/14	100
	МВН-500	19,9	2626	529			214
	МВН-600	30,6	2705	630			330
(16) Пароводяные санитарно-технических устройств двухходовые (Оргэнергострой)	МВН—2494				$p_y < 6$	(14) Латунные	
	—01	0,625	1772	159		16/14,5	10
	—02	0,95	2462	159			
	—03	1,62	1812	219		.	26
	—04	2,47	2502	219		.	
(17) То же, четырехходовые	—05	1,37	1772	219		.	22
	—06	2,09	2462	219			
	—07	2,24	1790	273		.	36
	—08	3,41	2480	273			
	—09	4,93	2530	325		.	52
(18) Пароводяные двухходовые (Сантехпроект)	7	4,47	2043	265	(19) Пара и воды $p_{раб}$=5	(14) Латунные 16/14	56
	8	5,66	2449	265			
	9	6,66	2849	265			
(20) То же, четырехходовые (НИИ Сантехники)					(21) Пара $p_{раб}$ = 6; (22) воды $p_{раб}$=5 (t = 150 °C)	(22a) Медные	
	1	1,47	1265	219		17/13	32
	2	1,93	1565	219			
	3	2,56	1965	219			
	4	3,18	2365	219			
	5	3,8	2765	219			
						(14) Латунные	
	6	3,5	1664	265		16/14	172
(23) То же					(19) Пара и воды $p_{раб}$ = 5	(14) Латунные	
	10	7,87	1509	414		16/14	172
	11	10,4	1809	414			
	12	13,75	2209	414			
	13	17,1	2609	414			
	14	20,4	3009	414			
(24) Водоводяные секционные (Мосэнергопроект)					$p_{раб}$ = 9 (t=150 °C)	(14) Латунные	
	3	1,32	4432	89		16/14	7
	4	2,26	4456	108		.	12
	6	5,84	4525	159		.	31
	8	10,35	4600	216		.	55
	10	16,6	4717	267		.	88
	12	26,4	4770	325		.	140
(24) Водоводяные секционные (Мосэнергопроект)					$p_{раб}$=9 (t=150 °C)	(14) Латунные	
	ВВП-50	0,75	4330	57		16/14	4
	—60	1,32	4410	70		.	7
	—80	2,26	4410	89		.	12
	—100	3,58	4580	114		.	19
	—150	6,95	4670	168		.	37

Key: (1). Preheaters. (2). Type and number. (3). Heating surface in m^2. (4). Size/dimensions in mm. (5). Parameters (P_{np} or $P_{pa\delta}$) in kg/cm^2. (6). Material of tubes. (7). length. (8) diameter. (9). size/dimensions in mm. (10). a quantity in pcs. (11). Steam-water fourway are long (TsITL). (12). Pressure is pair $P_{np}=11$ the pressure of water $P_{np}=20$. (13). Steel. (13a). The same. (14). Brass. (15). Steam-water fourway are short (Orgenergostroy). (16). Steam-water of sanitary-engineering devices two-pass (Orgenergostroy). (17). The same, fourway. (18). Steam-water two-pass (Santekhproyekt). 19). Steam and water $P_{pa\delta}=5$. (20). The same, fourway (NII [Scientific Research Institute] sanitary engineering). (21). Pair. (22). water. (22a). Copper. (23). The same. (24). Water-to-water sectional (Mosenergoproyekt).

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18.2. The thermal design of preheaters.

The basic formula of the thermal design

$$F=\frac{Q}{k\Delta t}, \qquad (18.1)$$

where F is a surface of heating preheater in m^2;

Q - the thermal load of preheater in gcal/h;

Δt - an average logarithmic difference in the temperatures between the heating and heated medium in °C;

k - the coefficient of heat transfer in kcal/m^2 h °C

The task of thermal design is testing the conformity of the pre-selected construction of preheater to the assigned/prescribed conditions.

Calculated data for steam-water preheaters.

With the single-stage preheating of water, the condensate of heating steam is cooled to 90-95°C because of primary preheating before water inflow into preheaters. A quantity pair in this case descends

$$D_{o.п} = \frac{Q_o}{(i'_{o.п} - i_{конд})\,\eta_{o.п}} = \frac{G(\tau_a - \tau'_{2\,ox})}{(i'_{o.п} - i_{конд})\,\eta_{o.п}}\ \mathbf{kg/h}, \quad (18.2)$$

where Q_o - quantity of heat, transferred with vapor into first stage of preheaters (from the selections of turbines) in kcal, h;

G - consumption of water in grid/network during design conditions in kg/h;

τ'_{2ox} - the temperature of the reverse/inverse network water before the coolant at calculated temperature of t and virtually equal to τ_2, into °C;

$i'_{o.п}$ - the enthalpy of heating steam in kcal/kg;

$i'_{o.п}$ - the enthalpy of condensate after preheater in kcal/kg;

$i'_{конд}$ — the enthalpy of the condensate of heating steam before the coolants of condensate in kcal/kg;

$\eta_{o.n.} = 0,99$ — the coefficient, which considers the heat loss by the surface of basic preheaters;

τ_a — the maximum possible temperature of the water, heated in basic preheaters in °C.

Quantity of heat, transferred to water in preheater,

$$Q_{o.n} = \frac{Q_o\,(i''_{o.n} - i'_{o.n})}{i''_{o.n} - i_{конд}}\ \text{kcal/h.} \tag{18.3}$$

Quantity of heat, transferred in coolant,

$$Q_{ox} = \frac{Q_o\,(i'_{o.n} - i_{конд})}{i''_{o.n} - i_{конд}}\ \text{kcal/h.} \tag{18.4}$$

Table 18.9. Fundamental design characteristics of tape/film preheaters (on the projects, carried out ORGRES [ОРГРЭС - State Trust for the Organization and Rationalization of Regional Electric Power Plants and Networks] for the different objects).

(1) Показатели	(2) Производительность в т/ч					
	12	30	60	80	100	120
(3) Поверхность нагрева в $м^2$	11,6	24,8	28	50	47	64
(4) Температура воды, поступающей в подогреватель в °С	5	12	70	5	20	5
(5) Температура воды после подогревателя в °С	103,9	103,6	103,5	103,9	103	103,9
(6) Диаметр корпуса в мм	$\frac{476}{458}$	$\frac{529}{513}$	$\frac{631}{613}$	$\frac{631}{613}$	$\frac{812}{800}$	$\frac{720}{700}$
(7) Высота корпуса в мм	1314	1615	1820	1610	2000	1750
(8) Полная строительная высота в мм	1554	2130	2120	2490	2855	2235
(9) Высота листов или концентрических труб в мм	труб 850	листов 700	труб 700	листов 1000	труб 1000	листов 1000
(10) Диаметр сопла в мм	$\frac{18,4}{28,4}$	$\frac{41}{51}$	$\frac{41}{51}$	$\frac{67}{77}$	$\frac{51}{57}$	$\frac{80}{90}$

Note. Vapor pressure of the heating, predominant in preheater p = 1.2 atm(abs.) with the temperature of saturation $t_{п} = 104,2°C$.

Key: (1). Indices. (2). Productivity in t/h. (3). Surface area of heating in m^2. (4). Temperature of the water, which enters the preheater in °C. (5). Temperature of water after preheater in °C. (6). Diameter of housing in mm. (7). Height/altitude of housing in mm. (8). Complete overall height in mm. (9). Height/altitude of plates or concentric tubes in mm. (10). Diameter of nozzle in mm.

Table 18.10. Drainage controllers for network preheaters of the type LMZ.

(1) Типоразмер	(2) Условный проход в мм	(3) Условное давление в ата	(4) Ориентировочная производительность в т/ч	(5) Присоединительные размеры штуцеров в мм		(6) Вес в т
				входной штуцер (7)	выходной штуцер (7)	
КГ 2,5—100—I	100	2,5	30—40	100	100	185
К 10—100—II	100	10	60—80	100	100	368
КИ 10—150—II	150	10	160	100	150	159
К 16—100—II	100	16	150	100	100	419

Note. Drainage controller KI 10-150-11 has the contact device of the signaling of the emergency lift of float.

Key: (1). Typical dimension. (2). The internal diameter in mm. (3). Conditional pressure in atm(abs.). (4). Tentative productivity in t/h. (5). The coupling dimensions of branches in mm. (6). Weight in t. (7). intake branch.

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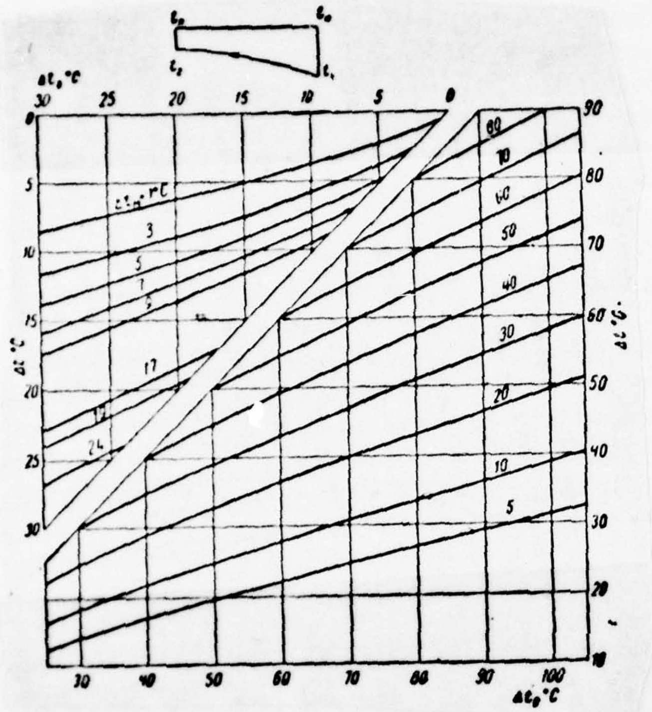

Fig. 18.9. Graph for determining log mean temperature difference at heat carrier vapor - to water.

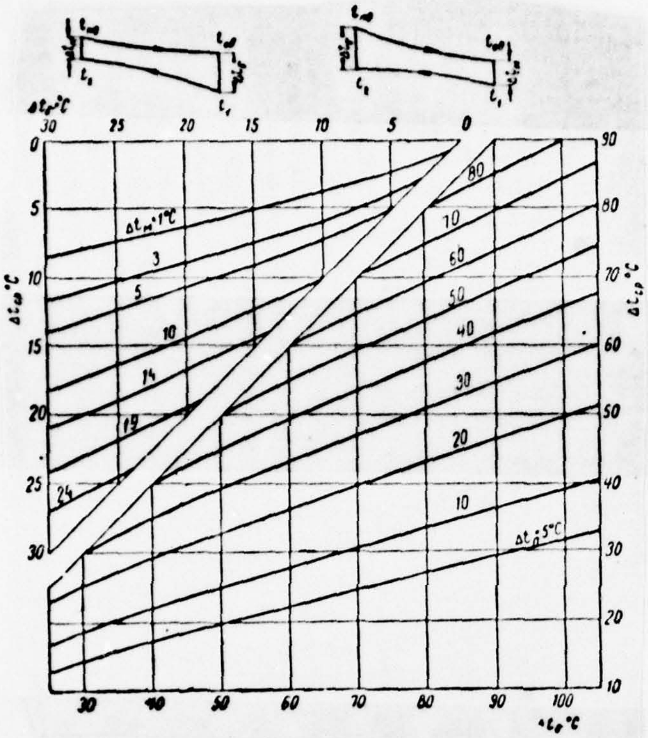

Fig. 18.10. Graph for determining log mean temperature difference at heat carrier water - water.

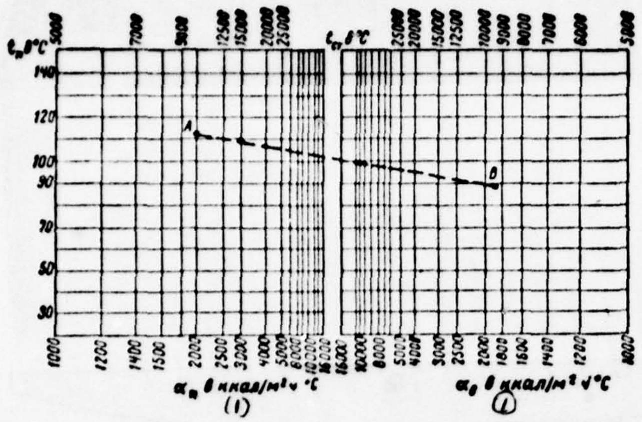

Fig. 18.11. Nomogram for determining the temperature of the wall of heating tubes.

Note. Simultaneously one should use the upper or lower scales for determination α.

Example. Is given $t_н = 110.8$ C, $\alpha_н = 10000$ (point A), $t_{ср} = 88.7°$ C, $\alpha_в = 9000$ (point B). Connecting point A and B, we will obtain that $t_{ст} = 100°$ C

Key: (1). kcal/m² h °C.

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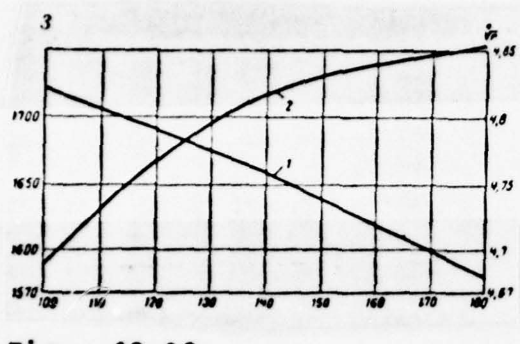

Fig. 18.12.

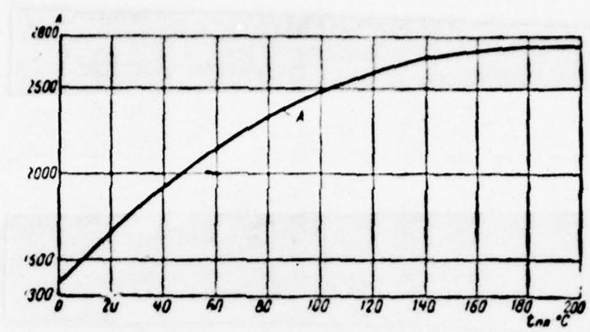

Fig. 18.13.

Fig. 18.12. Graph for determining the heat-transfer coefficient from the condensable vapor to the horizontal wall

$$1-\sqrt[4]{r};\quad 2-b=0.724\sqrt[4]{\frac{\gamma^2\lambda^3\cdot 3600}{\mu}}.$$

Fig. 18.13. Graph for determining the heat-transfer coefficient from the condensable vapor to vertical wall. Note. Value of the coefficient

$$A=1.13\sqrt[4]{\frac{\lambda^3\gamma^2\cdot 3600}{\mu}}.$$

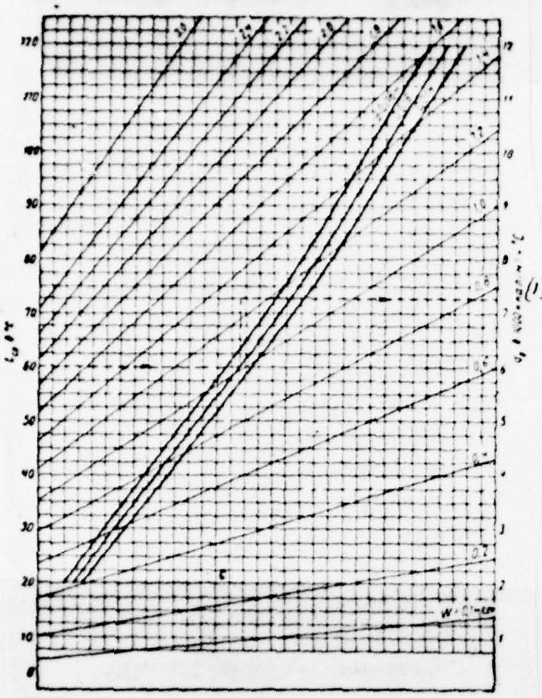

Fig. 18.14.

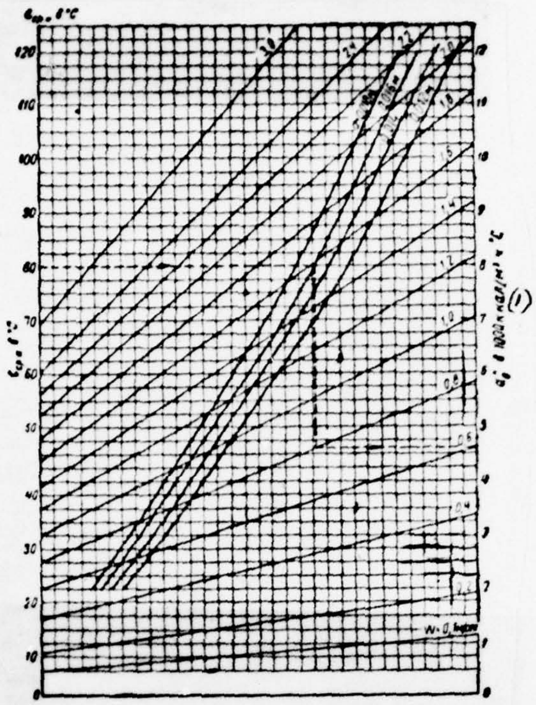

Fig. 18.15.

Fig. 18.14. Graph for determining the heat-transfer coefficient from water to wall with longitudinal flow during cooling, comprised by formula VTI. t_{cp}- mean temperature of the water-cooled; W is real speed of water. Key: (1). kcal/m³ h °C.

Fig. 18.15. Graph for determining the heat-transfer coefficient to water with longitudinal flow during heating.

comprised by formula VTI. $t_{ср.н}$ – mean temperature of the heated water.

Key: (1). kcal/m³ h °C.

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The temperature of water at the entry into coolant τ_{2ox} differs from τ_2 in view of addition of makeup water for the compensation of leakages and for providing the hot water supply with direct water sampling. With the addition, equal by x o/o with temperature $t_{доб}$.

$$\tau'_{2\,ox} = \frac{(100-x)\,\tau_2 + x t_{доб}}{100}\ {}^{\circ}\mathrm{C}. \qquad (18.5)$$

Temperature of water at the entry into basic preheater (after coolant)

$$\tau''_{2\,ox} = \tau'_{2\,ox} + \frac{Q_{ox}}{G}\ {}^{\circ}\mathrm{C}. \qquad (18.6)$$

When, in the circuit, peak preheaters are present, the condensate of heating steam they direct, as a rule, to steam space of basic preheaters. Consumption pair for basic preheaters in this case will compose

$$D_{o.n}=\frac{Q_o-D_{n.т}\,(i'_{n.n}-i_{конд})}{(i'_{o.n}-i_{конд})\,\eta_{n.n}}\ \text{kg/h}, \quad (18.7)$$

where $D_{n.т}$ — consumption is pair to the peak preheaters of heat and power plant in kg/h;

$i'_{n.n}$ — the enthalpy of the condensate of the peak preheaters of heat and power plant in kcal/kg;

$\eta_{n.n}=0{,}98$ — the coefficient, which considers the heat loss by the surface of peak preheaters.

Productivity of coolant in this case

$$Q_{ох}=(D_{o.n}-D_{n.т})\,(i'_{o.n}-i_{конд})\ \text{kcal/h}. \quad (18.8)$$

Consumption is pair to the peak preheaters

$$D_{n.т}=\frac{Q_{n.т}}{(i'_{n.n}-i'_{n.n})\,\eta_{n.n}}=$$
$$=\frac{G(\tau_{ш}-\tau_{х})}{(i'_{n.n}-i'_{n.n})\,\eta_{n.n}}\ \text{kg/h}. \quad (18.9)$$

where $i'_{n.n}$ — the enthalpy of heating steam for a peak preheater in kcal/kg;

$\tau_{в}$ – the temperature of water after peak preheaters in °C.

The thermal design of the coolants of condensate is produced by two conditional conditions/modes.

In the first conditions/mode it is assumed that entire condensate, which enters the coolant, boils up, forming pairs. Calculation is conducted just as steam-water preheater.

The parameters of the vaporized vapor are accepted according to saturation state with 20-30o/o of humidity. A quantity pair is determined from the formula

$$D_{в.п} = \frac{Q_{ох} \eta_{ох}}{i'_{в.п} - i_{конд}} = \frac{D_{о.п} \eta_{ох}}{i'_{оп} - i_{конд}} \text{ kg/h,} \quad (18.10)$$

where $i'_{в.п}$ – the enthalpy of the secondary steam at a pressure in preheater in kcal/kg;

$\eta_{ох} = 0{,}99$ – the coefficient, which considers the heat loss by the surface of heating the coolants of condensate.

In the second conditions/mode it is assumed that the condensate is under pressure, which eliminates its effervescence. Calculation is conducted just as water-to-water preheater cooled of condensate down to 90°C.

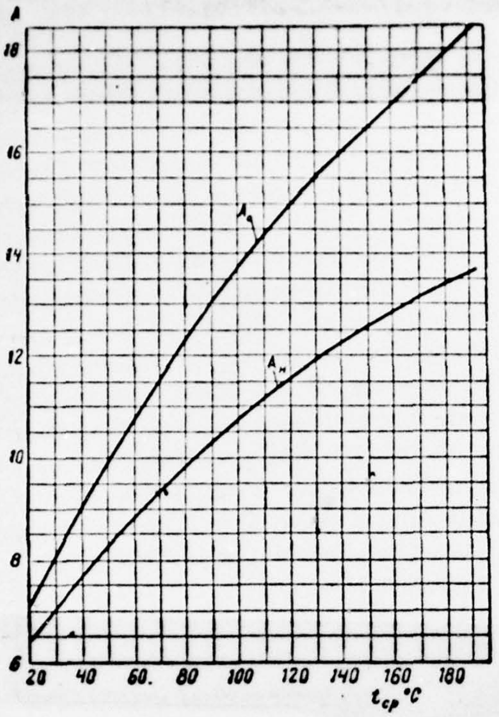

Fig. 18.16.

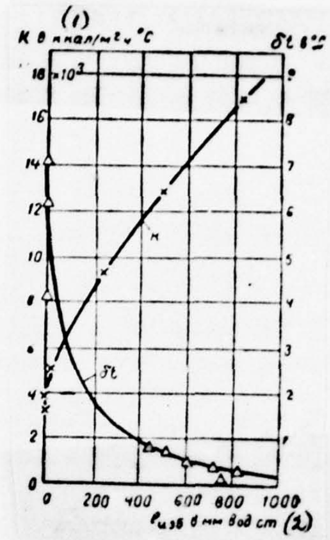

Fig. 18.17.

Fig. 18.16. Graph for determining the coefficients during cooling A_0 and heating $A_н$ of water.

Fig. 18.17. Results of the tests of tape/film preheaters with G = 190 t/h. K - the coefficient of heat transfer; u - heating water to temperature pair; $p_{изб}$- overpressure is steam.

Key: (1). kcal/m² h °C. (2). in mm of water cm.

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The surface of heating coolant is selected in the maximum value, obtained during.

Tables 18.11-18.13 gives forms and examples of the thermal design of surface preheaters.

The thermal design of tape/film preheaters is produced by the same formula (18.1), that also surface.

The coefficient of heat transfer in these preheaters in experimental data of ORGRES varies from 8000 to 15000 kcal m^2 h °C and usually is accepted 10000 kcal/m^2 h C. To Fig. 18.17, are given the results of the tests of tape/film preheaters, carried out by VTI.

The difference between the temperature of the saturated steam and the temperature of the heated water is recommended to accept 0.5-1°C.

Table 18.11. Standard form for the calculation of horizontal steam-water surface preheater (MVN 1437-58) and an example of calculation.

(1) Наименование элемента расчета	(2) Размерность	(3) Расчетные формулы и условные обозначения	(4) Расчетные величины
(5) Заданы:			
(6) Расчетный расход тепла	(7) ккал/ч	Q	$1{,}5 \cdot 10^6$
(8) Температура насыщения пара	°C	$t_п$	142,9
(9) Температура воды, входящей в подогреватель	•	t_1	70
(10) Температура воды, выходящей из подогревателя	•	t_2	130
(11) Средняя температура воды		$t_{ср} = \frac{t_1 + t_2}{2}$	100
(12) Разность температур на входе и выходе воды в подогревателе		$\Delta t = t_2 - t_1$	60
(13) Средняя логарифмическая разность температур между паром и водой (см. рис. 18.9)		$\Delta t_{ср} = \frac{t_2 - t_1}{2{,}3 \lg \frac{t_п - t_1}{t_п - t_2}}$	84,5
(14) Удельный вес воды при средней температуре	(14a) кг/м³	$\gamma_в$	958,4
(15) Скорость воды в трубках	(15a) м/сек	$W_в = \frac{Q}{3600 \gamma_в (t_2 - t_1) f_{тр}}$	1,45
(16) Коэффициент теплоотдачи от стенки к воде для продольного обтекания при нагревании (см. рис. 18.15)	(16a) ккал/м²ч °C	$\alpha_в = A_н (W_в \gamma_в)^{0,8} d_{вн}^{-0,2}$	8050
(17) Температура стенки трубок (см. рис. 18.11)	°C	$t_{ст} = \frac{\alpha_в t_{ср} + \alpha_п t_п}{\alpha_в + \alpha_п}$	118
(18) Разность между температурой насыщения пара и стенкой	•	$\vartheta = t_п - t_{ст}$	24,9
(19) Температура пленки конденсата	•	$t_{пл} = \frac{t_п + t_{ст}}{2} = t_п - \frac{\vartheta}{2}$	129,5
(20) Коэффициент теплоотдачи от конденсирующегося пара к горизонтальной стенке (см. рис. 18.12)	(16a) ккал/м² ч°C	$\alpha_п = b \sqrt[4]{\frac{r}{n_{пр} d_{нар} \vartheta}}$	6100
(21) Значение коэффициента b (см. рис. 18.12)	(22) (23) $\frac{ккал^{3/4}\, кг^{1/4}}{м^{7/4}\, °C^{3/4}\, ч}$	$b = 0{,}724 \sqrt[4]{\frac{\gamma^2 \lambda^3 \cdot 3600}{\mu}}$	1696
(24) Толщина слоя накипи и трубки	(16a) ккал/м ч °C	(24a) $\lambda_{нак}$ и $\lambda_{тр}$	0,0002 и 0,001 (24a)
(25) Коэффициент теплопроводности накипи и трубки	(16a) ккал/м ч °C	(24a) $\lambda_{нак}$ и $\lambda_{тр}$	(24a) 2 и 90

Continuation Table 18.11.

(1) Наименование элемента расчета	(2) Размерность	(3) Расчетные формулы и условные обозначения	(4) Расчетные величины
(26) Коэффициент теплопередачи	(16a) ккал/м² ч °С	$k = \dfrac{1}{1/\alpha_в + 1/\alpha_п + \dfrac{\delta_{тр}}{\lambda_{тр}} + \dfrac{\delta_{нак}}{\lambda_{нак}}}$	2570
(27) Расчетная поверхность нагрева	м²	$F_р = \dfrac{Q}{k \Delta t_{ср}}$	16,9
(28) Принятая поверхность по типовой конструкции	•	F	19,0

Key: (1). Designation of the cell/element of calculation. (2). Dimensionality. (3). Calculation formulas and the conventional designations. (4). Calculated values. (5). Are assigned/prescribed. (6). Calculated heat consumption. (7). kcal/h. (8). Saturation temperature pair. (9). Temperature of the water, entering the preheater. (10). Temperature of the water, coming out from preheater. (11). Mean temperature of water. (12). Difference in the temperatures at entrance and exit of water in preheater. (13). An average logarithmic difference in the temperatures between vapor and water (see Fig. 18.9). (14). The specific gravity/weight of water at mean temperature. (14a). kg/m³. (15). Speed of water in

tubes. (15a). m/s. (16). Heat-transfer coefficient from wall to water for a longitudinal flow during heating (see Fig. 18.15). (16a). kcal/m² h °C. (17). The temperature of the wall of tubes (see Fig. 18.11). (18). Difference between the temperature of saturation pair and wall. (19). Temperature of the film of condensate. (20). Heat-transfer coefficient from the condensable vapor to horizontal wall (see Fig. 18.12). (21). The value of coefficient of b (see Fig. 18.12). (22). kcal. (23). kg. (24). Thickness of the layer of scale deposit and tube. (25). Coefficient of the thermal conductivity of scale deposit and tube. (26). Coefficient of heat transfer. (27). Calculated heating surface. (28). Taken surface by standard design.

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Table 18.12. Standard form for the calculation of vertical surface steam-water preheater (side-looking-200) and an example of calculation.

(1) Наименование элемента расчета	(2) Размерность	(3) Расчетные формулы и условные обозначения	(4) Расчетные величины
(5) Заданы: (6) Расчетный расход тепла	(7) ккал/ч	Q	$15\cdot10^6$
(8) Температура насыщения пара	°C	$t_п$	126,8
(9) Температура воды, входящей в подогреватель и выходящей из подогревателя	»	(10) t_1 и t_2	(10) 70 и 110
(11) Средняя температура воды	»	$t_{ср} = \frac{t_1 + t_2}{2}$	90
(12) Разность температур на входе и на выходе в подогревателе	»	$\Delta t = t_2 - t_1$	40
(13) Среднелогарифмическая разность температур между паром и водой (см. рис. 18.9)	»	$\Delta t_{ср} = \frac{t_1 - t_2}{2{,}3 \lg \frac{t_п - t_1}{t_п - t_2}}$	33
(14) Удельный вес воды при средней температуре	(15) кг/м³	$\gamma_в$	965,3
(16) Площадь сечения трубок одного хода при числе трубок n в одном ходу	м²	$f_{тр} = \frac{\pi d_{вн}^2}{4} n$	0,0635
(17) Скорость воды в трубках	(18) м/сек	$W_в = \frac{Q}{3600 \cdot \gamma_в (t_2 - t_1) f_{тр}}$	1,64
(19) Коэффициент теплоотдачи от стенки к воде для продольного обтекания при нагревании (см. рис. 18.15)	(20) ккал/м² ч °C	$\alpha_в = A_н (W_в \gamma_в)^{0,8} d_{вн}^{-0,2}$	8450
(21) Температура стенки трубок (см. рис. 18.11)	°C	$t_{ст} = \frac{\alpha_в t_{ср} + \alpha_п t_п}{\alpha_в + \alpha_п}$	104
(22) Разность между температурой насыщения пара и стенкой	»	$\vartheta = t_п - t_{ст}$	22,8
(23) Температура пленки конденсата	»	$t_{пл} = t_п - \frac{\vartheta}{2} = \frac{t_п + t_{ст}}{2}$	115,4
(24) Коэффициент теплоотдачи от конденсирующегося пара к вертикальной стенке (см. рис. 18.13)	(20) ккал/м² ч °C	$\alpha_п = A \sqrt[4]{\frac{r}{H}}$	4920
(25) Значение коэффициента A (см. рис. 18.13)	(26) (27) $\frac{ккал^{3/4}\ кг^{1/4}}{м^{7/4}\ ч\ {}^\circ C^{3/4}}$	$A = 1{,}13 \sqrt[4]{\frac{\lambda^3 \gamma^2 \cdot 3600}{\mu}}$	2570

Continuation table 18.12.

(1) Наименование элемента расчета	(2) Размерность	(3) Расчетные формулы и условные обозначения	(4) Расчетные величины
(28) Длина пути конденсата вдоль поверхности теплообмена до промежуточной горизонтальной перегородки	м	H	1,72
(29) Теплота парообразования при $t_п$	(7) ккал/кг	r	521,1
(30) Толщина слоя накипи и стенки трубки	м	$\delta_{нак}$ (10) и $\delta_{тр}$	0,0002 (10) и 0,001
(31) Коэффициент теплопроводности слоя накипи и стенки трубки	(20) ккал/м ч °С	$\lambda_{нак}$ (10) и $\lambda_{тр}$	(10) 2 и 90
(32) Коэффициент теплопередачи	(20) ккал/м² ч °С	$k = \dfrac{1}{1/\alpha_в + 1/\alpha_п + \dfrac{\delta_{тр}}{\lambda_{тр}} + \dfrac{\delta_{нак}}{\lambda_{нак}}}$	2320
(33) Расчетная поверхность нагрева	м²	$F_р = \dfrac{Q}{k \Delta t_{ср}}$	196
(34) Принятая поверхность по типовой конструкции	»	F	200

Key: (1). Designation of the cell/element of calculation. (2). Dimensionality. (3). Calculation formulas and the conventional designations. (4). Calculated values. (5). Are assigned/prescribed. (6). Calculated heat consumption. (7). kcal/h. (8). Saturation temperature pair. (9). Temperature of the water, entering the preheater and coming out from preheater. (10). and. (11). Mean temperature of water. (12).

Difference in the inlet temperatures and at output/yield in preheater. (13). Log mean temperature difference between vapor and water (see Fig. 18.9). (14). The specific gravity/weight of water at mean temperature. (15). kg/m³. (16). Cross-sectional area of the tubes of one course with the number of tubes n in one course. (17). Speed of water in tubes. (18). m/s. (19). Heat-transfer coefficient from wall to water for a longitudinal flow during heating (see Fig. 18.15). (20). kcal/m² h °C. (21). The temperature of the wall of tubes (see Fig. 18.11). (22). Difference between the temperature of saturation pair and wall. (23). Temperature of the film of condensate. (24). Heat-transfer coefficient from the condensable vapor to vertical wall (see Fig. 18.13). (25). The value of coefficient of A (see Fig. 18.13). (26). kcal. (27). kg. (28). Path length of condensate along surface of heat exchange up to intermediate horizontal partition/baffle. (29). Heat of vaporization when (30). Thickness of the layer of scale deposit and wall of tube. (31). Coefficient of the thermal conductivity of the scale deposit and wall of tube. (32). Coefficient of heat transfer. (33). Calculated heating surface. (34). Taken surface by standard design.

Table 18.13. Standard form for the thermal design of the surface water-to-water preheater of MVN 2050-34/Z and an example.

(1) Наименование элемента расчета	(2) Размерность	(3) Расчетные формулы и условные обозначения	(4) Расчетные величины
(5) Заданы: (6) Расчетный расход тепла	(7) ккал/ч	Q	$3\cdot10^6$
(8) Температура греющей воды на входе и выходе	°C	(10) $t_{п.в}$ и $t_{о.в}$	(10) 70 и 35
(9) Температура нагреваемой воды на входе и выходе	»	(10) t_1 и t_2	(10) 6 и 60
(11) Средняя температура греющей воды	»	$t_{ср.г} = \frac{t_{п.в} + t_{о.в}}{2}$	52,5
(12) Средняя температура нагреваемой воды	»	$t_{ср.н} = \frac{t_1 + t_2}{2}$	32,5
(13) Большая и меньшая разность температур между греющей и нагреваемой водой	»	$\Delta t_б$ и $\Delta t_м$	(10) 30 и 10
(14) Среднелогарифмическая разность температур между нагреваемой и греющей водой (см. рис. 18.10)	»	$\Delta t_{ср} = \frac{\Delta t_б - \Delta t_м}{2{,}3 \lg \frac{\Delta t_б}{\Delta t_м}}$	18,2
(15) Разность температур входящей и выходящей воды в трубном и межтрубном пространстве (задано)	°C	(10) $\Delta t_{тр}$ и $\Delta t_{пр}$	(10) 35 и 55
(16) Удельные веса при средних температурах воды в трубном и межтрубном пространстве	(16a) кг/м³	(10) $\gamma_{тр}$ и $\gamma_{пр}$	(10) 994,8 и 986,8
(17) Скорость воды в трубках	(17a) м/сек	$W_{тр} = \frac{Q}{3600\, \gamma_{тр}\, \Delta t_{тр}\, f_{тр}}$	1,43

Continuation Table 18.13.

(1) Наименование элемента расчета	(2) Размерность	(3) Расчетные формулы и условные обозначения	(4) Расчетные величины
(18) Скорость воды в межтрубном пространстве	(17a) м/сек	$W_{пр} = \frac{Q}{3600\, \gamma_{пр}\, \Delta t_{пр}\, f_{пр}}$	0,5
(19) Коэффициент при остывании (см. рис. 18.16)	—	$A_o = 0{,}0263 \frac{\lambda\, Pr^{0.35}}{\eta_t^{0.8}}$	9,8
(20) Коэффициент при нагревании (см. рис. 18.16)	—	$A_н = 0{,}0209 \frac{\lambda\, Pr^{0.45}}{\eta_t^{0.8}}$	7,2
(21) Коэффициент теплоотдачи при охлаждении воды (см. рис. 18.14)	(22) ккал/м² ч °С	$\alpha'_в = A_o\, (\gamma_o W_o)^{0.8}\, d^{-0.2}$	7500
(23) Коэффициент теплоотдачи при нагревании воды (см. рис. 18.15)	(22) ккал/м² ч °С	$\alpha''_в = A_н\, (\gamma_н W_н)^{0.8}\, d^{-0.2}$	2300
(24) Толщина слоя накипи и стенки трубки	м	$\delta_{нак}$ и $\delta_{тр}$	0,0005 и 0,001
(25) Коэффициент теплопроводности материала накипи и трубки	(22) ккал/м ч °С	$\lambda_{нак}$ и $\lambda_{тр}$	2 и 90
(26) Расчетный коэффициент теплопередачи	(22) ккал/м² ч °С	$k = \frac{1}{1/\alpha'_в + 1/\alpha''_в + \frac{\delta_{тр}}{\lambda_{тр}} + \frac{\delta_{нак}}{\lambda_{нак}}}$	1220
(27) Выбранная поверхность по типовой конструкции	м²	$F_п$	144,2
(28) Активная длина трубок	м	$L = \frac{F_п}{\pi\, d_{ср}\, n} = lz$	28
(29) Выбранная длина одной секции	•	l	4
(30) Число секций	(31) шт.	$z = L : l$	7

Note. Pr - Prandtl number, η absolute viscosity in kg/s•m.

Key: (1). Designation of the cell/element of calculation. (2). Dimensionality. (3). Calculation formulas and the conventional designations. (4). Calculated values. (5). Are assigned/prescribed. (6). Calculated heat consumption. (7).

kcal/h. (8). Temperature of the heating water at entrance and exit. (9). Temperature of the heated water at entrance and exit. (10). and. (11). Mean temperature of the heating water. (12). Mean temperature of the heated water. (13). Larger and smaller difference in the temperatures between heating and heated water. (14). Mean logarithmic difference in the temperatures between heated and heating water (see Fig. 18.10). (15). A difference in the temperatures of the entering and coming out water in tube and intertube space (is assigned/prescribed). (16). Specific gravity/weights at mean temperatures of water in tube and intertube space. (16a). kg/m³. (17). Speed of water in tubes. (17a). m/s. (18). Speed of water in intertube space. (19). The coefficient with cooling (see Fig. 18.16). (20). The coefficient of pi heating (see Fig. 18.16). (21). The heat-transfer coefficient during cooling of water (see Fig. 18.14). (22). kcal/m² h °C. (23). The heat-transfer coefficient during heating of water (see Fig. 18.15). (24). Thickness of the layer of scale deposit and wall of tube. (25). Coefficient of the thermal conductivity of the material of scale deposit and tube. (26). Calculated coefficient of heat transfer. (27). Selected surface by standard design. (28). Active length of tubes. (29). Selected length of one section. (30). Number. (31). pcs.

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18.3. Loss of head of water in preheaters.

The loss of head of water in preheater is determined from the formula

$$\Delta h = \Delta h_{т} + \Delta h_{м} = \frac{\lambda_{т}\gamma}{2gd_{вн}} lz\, W_{в}^{2} + \frac{\gamma}{2g}\Sigma\xi W_{н}^{2} \text{ mm of water. cm.} \quad (18.11)$$

where $\Delta h_{т}$ and $\Delta h_{м}$ – losses of head to friction and local resistance;

$\lambda_{т}$ – the coefficient of friction are determined from formula for rough tubes;

γ - the specific gravity/weight of water at mean temperature in kg/m^3;

g - the acceleration of gravity in m/s^2;

l - the length of one course in m;

$\Sigma\xi$ - the sum of the coefficients of local resistance;

W_s - the speed of water in tubes or in intertube space.

Formula (18.11) can be presented in the form

$$\Delta h = lll W_s^2 \text{ m of water. cm.} \quad (18.12)$$

Values of Sh are given in table 18.14, 18.15.

During the determination of values of Sh, it is accepted that $\gamma_s = 1000$ kg/m^3.

Local resistance ξ: for intake and downstream chambers - on 1.5; for rotations through 180° with the transition from one cluster to another inside the chamber - 2.5; for rotations through 180° during transition of one section to another through the elbow - 1.7.

Value $\lambda_т$ for horizontal steam-water and water-to-water preheaters according to MVN 1436-58, 1437-58 and 2050-57 is calculated for the brass tubes $d_{вн}=16$ mm and $k_ш=0,0002$ mm comprises $\lambda_т=0,041$. Value $\lambda_т$ for vertical steam-water preheaters is calculated with $d_{вн}=17,5$ mm and $k_ш=0,0002$ mm comprises $\lambda_т=0,04$.

The number of rotations in water-to-water preheaters with the pass of water in tubes is accepted equal to the number of sections minus unity.

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For water-to-water preheaters coefficients of local resistance in intertube space, the referred to speed water into intertube space it is perpendicular to tubes - 1; on leaving of water from intertube space at an angle of 90° - 1; during transition of one section to another at an angle of 90° in intertube space, - 2, with the bending of four partition/baffles, which support tubes, with the reference of coefficient to the speed of water in intertube space - 2.

Table 18.14. Values of Sh at the conditional length of course or section, equal to 1 m.

(1) Подогреватели		(2) Число ходов или секций	(3) Формула для определения Ш	(4) Ш при длине хода или секции в 1 м
(8) Пароводяные	(5) горизонтальные	(6) Ш для двух ходов	0,262 l+0,28	0,542
		(7) Ш для четырех ходов	0,521 l+0,536	1,057
	(9) вертикальные	(6) Ш для двух ходов	0,24 l+0,28	0,52
		(7) Ш для четырех ходов	0,48 l+0,536	1,016
(13) Водоводяные горизонтальные	(10) вода в латунных трубках	(11) Ш для одной секции	0,131 l+0,153	0,284
		(12) Ш для двух секций	0,262 l+0,239	0,501
	(14) вода в межтрубном пространстве	(11) Ш для одной секции	0,131 l+0,204	0,335
		(12) Ш для двух секций	0,262 l+0,408	0,67

Key: (1). Preheaters. (2). Number of courses or sections. (3). Formula for determination of Sh. (4). of Sh at the length of course or section 1 m. (5). horizontal. (6). Sh for two courses. (7). Sh for four courses. (8). Steam-water. (9). vertical. (10). Water in brass tubes. (11). Sh for one section. (12). Sh for two sections. (13). Water-to-water horizontal. (14). water in intertube space.

Table 18.15. Value of coefficient Sh for the preheaters of different types.

(1) Тип подогревателя	(2) Пароводяные горизонтальные				(3) Водоводяные горизонтальные (вода в трубках)				(4) Водоводяные горизонтальные (вода в межтрубном пространстве)			
	(5) двухходовые с длиной хода в м		(6) четырехходовые с длиной хода в м		(7) односекционные с длиной хода в м		двухсекционные с длиной секции (8) в м		(9) односекционные с длиной секции в м		(10) двухсекционные с длиной секции в м	
	2	4	2	4	2	4	2	4	2	4	2	4
Ш	0,804	1,328	1,58	2,62	0,415	0,677	0,763	1,287	0,67	1,34	1,34	2,68
(11) Пароводяные вертикальные												
(1) Тип подогревателя	БО-550; БПр-550	БО-550-3К	БП-500	БО-350; БПР-350	БП-300	БО-200	БП-200	БО-130	БО-90	БП-90	БП-65	БП-43
Ш	1,38	1	1,3	1,2	1	1,93	0,88	1,38	1,19	0,59	0,58	1,67

Key: (1). Type of preheater. (2). Steam-water horizontal. (3). Water-to-water horizontal (water in tubes). (4). Water-to-water horizontal (water in the intertube space). (5). two-pass with the length of course in m. (6). fourway with the length of course in m. (7). single-section with the length of course in m. (8). two-section with length sections in m. (9). single-section with length sections in m. (10). two-section with length sections in m. (11). Steam-water vertical.

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Chapter 19.

THERMAL POINT.

Central thermal point/items are erected during the input/introduction of main-line thermal networks to the territory of industrial enterprises to an account the tempered from heat and power plant or from the district boiler room of heat, monitoring of the parameters of heat carriers and organizations of the additional control of heat distribution.

Figure 19.1 gives the exemplary/approximate schematic of the layout of the central thermal point/item of industrial enterprise. The dimensions of the locations of thermal point/items are determined of the conditions of providing

the pass among the protruding equipment components and the wall not less than 1 1.

By institute Mosproyekt [Institute for the Planning of Housing and Civil Engineering Construction in the City of Moscow] are developed the standard projects of the central thermal point/items of the quarters of city with the preheaters of hot water supply and pumping of displacement for heating systems (Fig. 19.2).

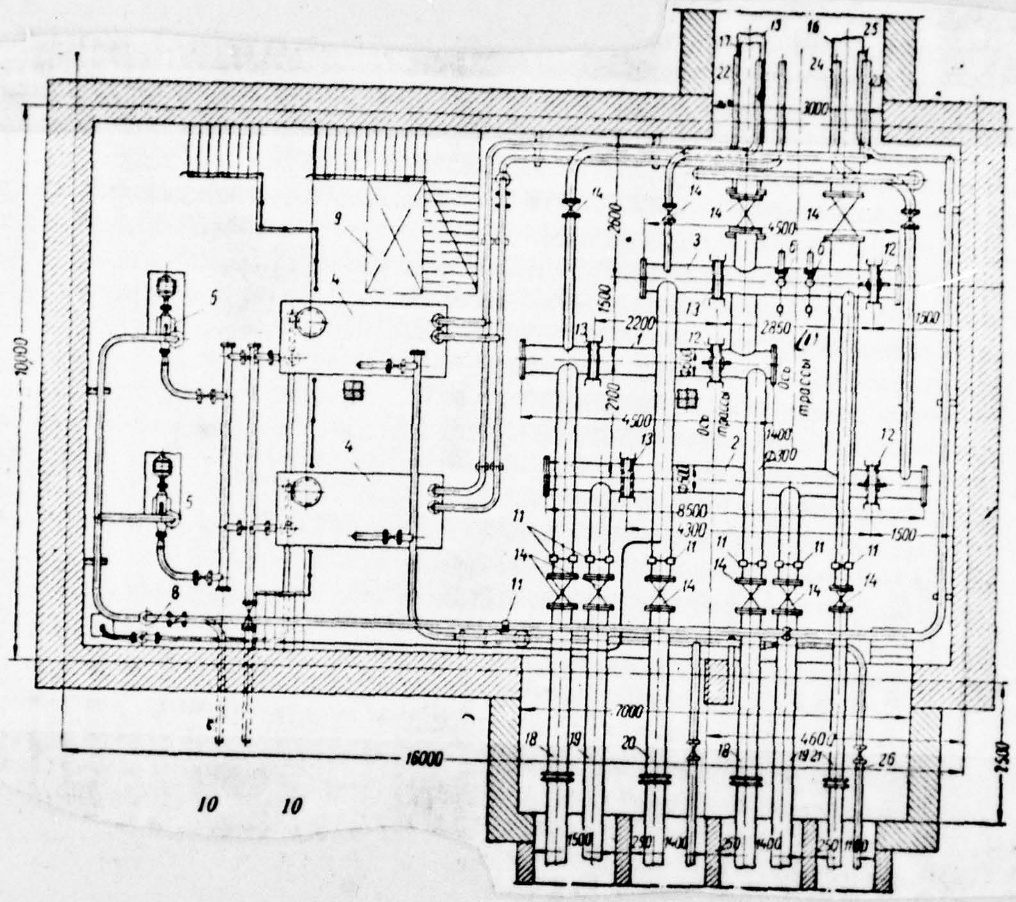

Fig. 19.1. Exemplary/approximate schematic of layout of central thermal point/item of industrial enterprise from heat and power plant: 1 - collector/receptacle of feeding water; 2 - collector/receptacle of reverse/inverse water; 3 - collector/receptacle steam line; 4 - tanks for condensate; 5 - pumps for pumping of condensate; 6 - safety valves; 7 - carrier-rings orifice; 8 - steam-jet elevator; 9 -

assembling window; 10 - into well of drain; 11 - strap supports; 12 - fixed supports; 13 - movable supports; 14 - catch; 15 - water line feeding ø 500 mm; 16 - water line reverse/inverse ø 500 mm; 17 - steam line ø 400 mm; 18 - water line feeding ø 300 mm; 19 - water line reverse/inverse ø 300 mm; 20 - steam line ø 250 mm; 21 - steam line ø 200 mm; 22 - steam line ø 100 mm; 23 - water line feeding ø 150 mm; 24 - water line reverse/inverse ø 150 mm; 25 - condensate piping forcing ø 125 mm; 26 - condensate piping self-flowing ø 80 mm.

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The connections of the preheaters of hot water supply are accepted two-stage: consecutive and mixed.

In some systems central thermal point/items are erected during the input/introduction of thermal network into quarter with the preservation/retention/maintaining of two-funnelled distributive thermal network without a change in the taken graph of temperatures. The basic designation/purpose of such point/items is the centralized account of heat distribution to quarter and centralized control of the hydraulic

conditions/mode of entire group of the buildings of quarter (Fig. 19.3).

The norms of quality in carbonate hardness and oxygen content for the water, which enters the local systems of hot water supply in the closed systems of thermal networks, are not establish/installed. Experience in operation will show the need for its preliminary treatment, in essence deaeration, to avoid the intense internal corrosion of tubes. In connection with this in central thermal point/items in closed system, are provided for the settings up on deaeration and the stabilizations of water, but with water by rigidity it is more than 4 mg•equiv/liter -, also, on its softening.

Settings up on water treatment for hot water supply are applied simpler than for makeup water of heat and power plant or boiler rooms.

In project indicated above standard of Mosproyekt, is provided for the setting up of dolomite (magnesium-mass) filters.

The method of protection with the aid of dolomite

filters is based on creation on the walls of tubes and equipment of the passivating coatings.

The fired dolomite absorbs from water entire aggressive equilibrium carbon dioxide, discharges part and the part of bicarbonate salts, forcing them to separate out to the surface of tubes in the form of carbonates, which passivate the process of corrosion.

Simultaneously as a result of the elimination of aggressive carbonic acid grow/rises pH of water, which decreases its activity.

The maintenance of filters is reduced to the replacement (approximately one time per annum) of the filter bed of dolomite and the periodic flushing of filter by return current of water.

In the thermal point/items of some cities for the deaeration of water of hot water supply, is applied the installation of steel-shavings filters (Fig. 19.4).

Hot water after preheater enters steel-shaving filter, then it passes through the marble or quartz filter. Marble grit absorbs from water dissolved carbonic acid,

transfer/converting to soluble bicarbonate of calcium.

The work of steel-shaving filters is considered satisfactory, if the oxygen content in water after filter on 1.5-3 mg/l is less than its critical solubility at this temperature and atmospheric pressure.

Each user of heat (habitable, public or industrial building) must have, as a rule, one thermal point/item. For large buildings is allow/assumed the device of several thermal point/items.

On the basis of character and quantity of placed equipment, the size/dimensions of locations for the thermal point/items of separate buildings tentatively can be accepted: for habitable and public buildings without hot water supply - 1.5 x 4 m at height/altitude 2 m; for habitable and public buildings with hot water supply in closed system - 5 x 8 at height/altitude 2.8 m.

Thermal point/items must have ventilation and electric lighting, but in the presence of water-heating installation setting up and pumping, furthermore, telephone communication with the dispatcher of the thermal network of area.

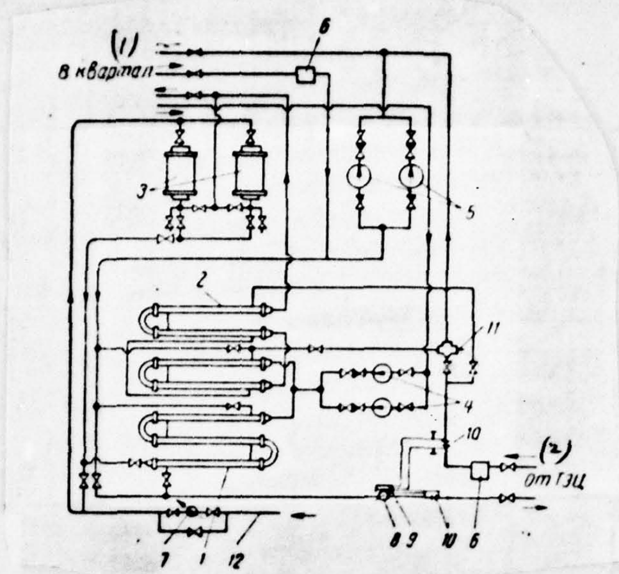

Fig. 19.2. Schematic diagram of central thermal point/item of quarter of city in closed system. 1 - preheater of first stage; 2 - preheater of the second step/stage; 3 - dolomite filters; 4 - circulating pumps of hot water supply; 5 - mixing network pumps; 6 - sludge pans; 7 - water meter on cold water; 8 - water meter on reverse/inverse network water; 9 - heat-counter; 10 - diaphragm; 11 - three-way valve; 12 - water pipe.

Key: (1). In quarter. (2). From TZTs.

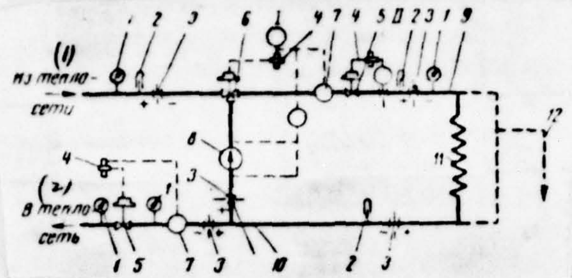

Fig. 19.3. Schematic diagram of central thermal point/item of quarter of city with open system. 1 - manometer; 2 - thermometer; 3 - measuring diaphragm; 4 - hydraulic relay of type RD-3a; 5 - single-pass control valve with diaphragm servomotor; 6 - the same, but two-pass; 7 - pressure impulse; 8 - pump of displacement; 9 - feed pipe; 10 - reverse/inverse main line; 11 - quarterly network; 12 - selection of water to hot water supply; I - regulator of mixing; II - flow regulator.

Key: (1). From heating system. (2). To heating system.

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The local water heating systems and ventilation are connected: a) to water thermal networks, as a rule,

according to direct circuit; b) to steam thermal networks - according to independent circuit with the setting up of local steam-water preheaters.

Independent connection to water thermal networks is applied for the systems of separate buildings, if their direct connection is led to the complication of the hydraulic mode of the system of thermal networks. For example, according to independent circuit connect high-altitude buildings; the unit buildings, arrange/located on the considerably higher or lower marks of the earth/ground with respect to thermal area; the separate buildings whose local systems are designed to pressure, considerably smaller than the remaining buildings of area and, etc.

If the calculated temperature of water in the local system lower than calculated temperature of water in thermal network, in thermal point/item are provided for the mixing devices. As the mixing devices of the local systems of hot-water heating, are applied the steel water-jet elevators of the construction of VTI - the heating system of the Mosc power system Admin. The elevator of the indicated construction is given in Fig. 19.5. Table 19.1 gives the

basic structural/design dimensions of elevators.

The procedure of calculation of water-jet elevators is given in table 19.2. Figures 19.6 depicts nomogram for determining the diameter of nozzle and number of elevator.

Water-jet elevators are applied for heating systems with calculated loss of pressure not more than 1.5 m water column. To one elevator it is permitted to connect the group of small buildings with total heat consumption for heating 0.3 gcal/h under the condition of alignment/levelling losses of head in branches to separate buildings. In this case, the resistance of distribution networks, including heating system, must not exceed 1 m water column.

With the insufficient available pressure in thermal network for the work of elevator, the mixing is realize/accomplished by centrifugal pumps. In this case is possible also the circuit with the joint operation of elevator and pump of the construction of TsNIIPS. Technical characteristic and the common/general/total data of pumps of TsNIIPS are given in table 19.3.

Where the temperature of water in heating system is

not limited (sport halls, basins, baths, laundry, commercial locations, the assignments of public nutrition by volume 500 m^3 and more, the industrial buildings), direct connection to thermal networks it is realize/accomplished without mixing of water from return line.

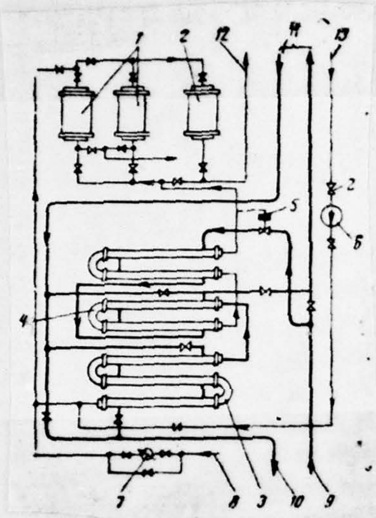

Fig. 19.4.

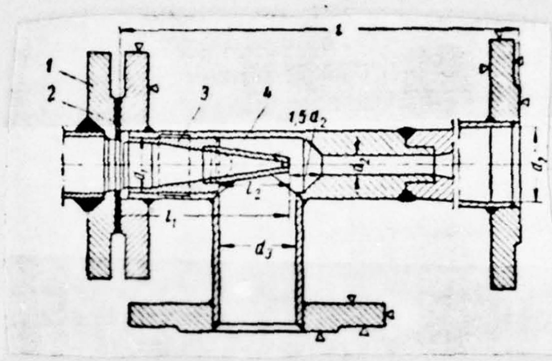

Fig. 19.5.

Fig. 19.4. Schematic of preheating setting of hot water supply with deaeration by steel-shaving filters in central thermal point/item of quarter of city. 1 - steel-shaving filter; 2 - quartz filter; 3 - preheater of first stage; 4 - preheater of the second step/stage; 5 - temperature regulator; 6 - circulating pump: 7 - water meter; 8 - water pipe; 9 - feeding line from thermal network; 10 - reverse line into thermal network; 11 - for the heating of quarter; 12 - line of hot water supply; 13 - circulation line of the system of hot water supply.

Fig. 19.5. Steel elevator of construction VTI - heating system of Mosc power system Admin. 1 - shaped flange; 2 - packing; 3 - nozzle; 4 - replacement part of the nozzle.

Table 19.1. Basic structural/design dimensions of elevators.

(1) Номер элеватора	(2) Общая длина в *мм*	(3) Диаметр горловины $d_г$ в *мм*	(4) Внутренние диаметры присоединительных патрубков в *мм*			(5) Длина сопла в *мм*		(6) Вес (без дополнительного фланца) в *кг*	(7) Пределы экономичной подачи смешанной воды при потере напора в системе 0,1 *кгс см²* *м³/ч*
			(8) входного d_1	(9) выходного d_2	(10) подсоса d_3	(11) полная l_1	(12) сменной части l_2		
1	425	15	37	51	51	110	55	100	1—4
2	425	20	37	51	51	100	45	100	4—7
3	625	25	49	82	70	1[illegible]5	50	150	7—10
4	625	30	49	82	70	135	40	150	10—15
5	625	35	49	82	70	1[illegible]5	30	150	15—22
6	720	47	80	100	100	175	60	230	22—39
7	720	59	80	100	100	155	40	230	39—50

Key: (1). Number of elevator. (2). Overall length in mm. (3). Diameter of throat/neck $d_г$ in mm. (4). Bores of connecting branch connections in mm. (5). Length of nozzle in mm. (6). Weight (without additional flange) in kg. (7). Limits of economical supply of the mixed water with loss of head in system 0.1 kgf cm² m³/h. (8). input. (9). output. (10). suction. (11). complete. (12) . replaceable part.

Table 19.2. **Different formulas for determining the nozzle of elevator.**

(1) Условные обозначения	(2) Наименования	(3) Единица измерения	(4) Расчетная формула	(5) Номер формулы
q	(6) Расчетный коэффициент инжекции (смешения) элеватора	—	$q = \frac{G_п}{G_э} 1{,}15 = \frac{\tau_1 - t_1}{t_1 - t_2} 1{,}15,$ (7) где 1,15 – коэффициент, полученный на основании экспериментальных данных Теплосети Мосэнерго	(19.1)
$G_э$	(8) Расход теплофикационной (эжектирующей) воды	(9) $m/ч$	$G_э = \frac{Q}{(\tau_1 - \tau_2)\,1000}$	(19.2)
$G_{см}$	(9a) Расход смешанной воды	.	$G_{см} = \frac{Q}{(t_1 - t_2)\,1000}$	(19.3)
$G_{пр}$	(10) Приведенный расход смешанной воды	.	$G_{пр} = \frac{G_{см}}{\sqrt{h}} = \frac{Q}{\sqrt{h}\,(t_1 - t_2)1000}$	(19.4)
$d_г$	(11) Диаметр горловины (камеры смешения) элеватора	$см$	$d_г = 0{,}874 \sqrt{G_{пр}}$	(19.5)
d_c	(12) Диаметр сопла элеватора	$мм$	$d_c = \frac{10\, d_г}{\sqrt{\frac{0{,}78}{G_{пр}^2}(1+q)^2 d_г^4 + 0{,}6(1+q)^2 - 0{,}4\, q^2}}$	(19.6)
H	(13) Требуемый напор перед элеватором	(14) $м$ вод. ст.	$H = 0{,}64 \frac{G_э^2}{d_c^4}$	(19.7)
d_c	(15) Диаметр сопла по располагаемому напору перед элеватором H	$см$	$d_c = \sqrt[4]{\frac{0.64 G_э^2}{H}}$	(19.8
$G_э$	(16) Расход теплофикационной воды по располагаемому напору перед элеватором и диаметру сопла	(9) $m/ч$	$G_э = \frac{d_c^2}{0.8}\sqrt{H}$	(19.9)
Q	(17) Расход тепла на отопление	(18) ккал/ч	—	
τ_1	(19) Температура воды в подающей трубе тепловой сети	°C	—	—
τ_2	(20) Температура воды в обратной трубе тепловой сети	.	—	—
t_1	(21) Температура воды в подающей трубе местной системы отопления	.	—	—
t_2	(22) Температура воды в обратной трубе местной системы отопления	.	—	—
h	(23) Гидравлическое сопротивление местной системы отопления	(25) $м$ вод. ст.	—	—
$G_п$	(24) Количество подмешиваемой воды из местной системы отопления	$m/ч$ (9)	—	—

Key: (1). The conventional designations. (2). Designations. (3). Unit of measurement. (4). Calculation formula. (5). Number of formula. (6). Calculated coefficient of the injection (displacement) of elevator. (7). where 1.15 is the coefficient, obtained on the basis of the experimental data of the heating system of the Mosc power system Admin. (8). Consumption of thermoficated (ejecting) water. (9). m/h.
(9a) Flow rate of mixed water.
(10). Given consumption of the mixed water. (11). Diameter of the neck (mixing chamber) of elevator. (12). Diameter of the nozzle of elevator. (13). Required pressure before the elevator. (14). m H_2O. (15). Diameter of nozzle on the available pressure before elevator H. (16). Consumption of thermoficated water according to the available pressure before the elevator and diameter of nozzle. (17). Heat consumption for heating. (18). kcal/h. (19). Temperature of water in the supply pipe of thermal network. (20). Temperature of water in run-back of thermal network. (21). Temperature of water in the supply pipe of local heating system. (22). Temperature of water in run-back of local heating system. (23). Hydraulic resistance of local heating system. (24). Quantity of mixed water from local heating system. (25). m H_2O.

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In closed systems the connection of the local systems of hot water supply is realize/accomplished according to the independent circuit through water-to-water preheaters, while in the open systems - it is direct to feeding and return lines of the input/introduction of thermal network.

The basic schematic diagrams of the connection of the local heating systems, ventilation and hot water supply to two-funnelled water networks and the conditions of their application/use are given in table 19.4.

For alignment/levelling of the diurnal graph of the load of hot water supply, is recommended the setting up of accumulator tanks in baths, laundry, shower public and industrial buildings, in hospitals and sanatoriums with mud and water cure.

The capacitance of tank-storage battery/accumulators for baths and laundries is determined in accordance with SNiP II- L.13-62 and II- L.14-62.

For shower public and industrial buildings the

capacitance of tank-storage battery/accumulators is recommended to accept depending on the number of established/installed shower bath systems, accepting the time of the charge of tanks in accordance with table 19.5.

For large shower and mud-baths, is allow/assumed to determine the capacitance of tank-storage battery/accumulators on the basis of the continuous feed of the hourly mean consumption of water for the days of the greatest water consumption.

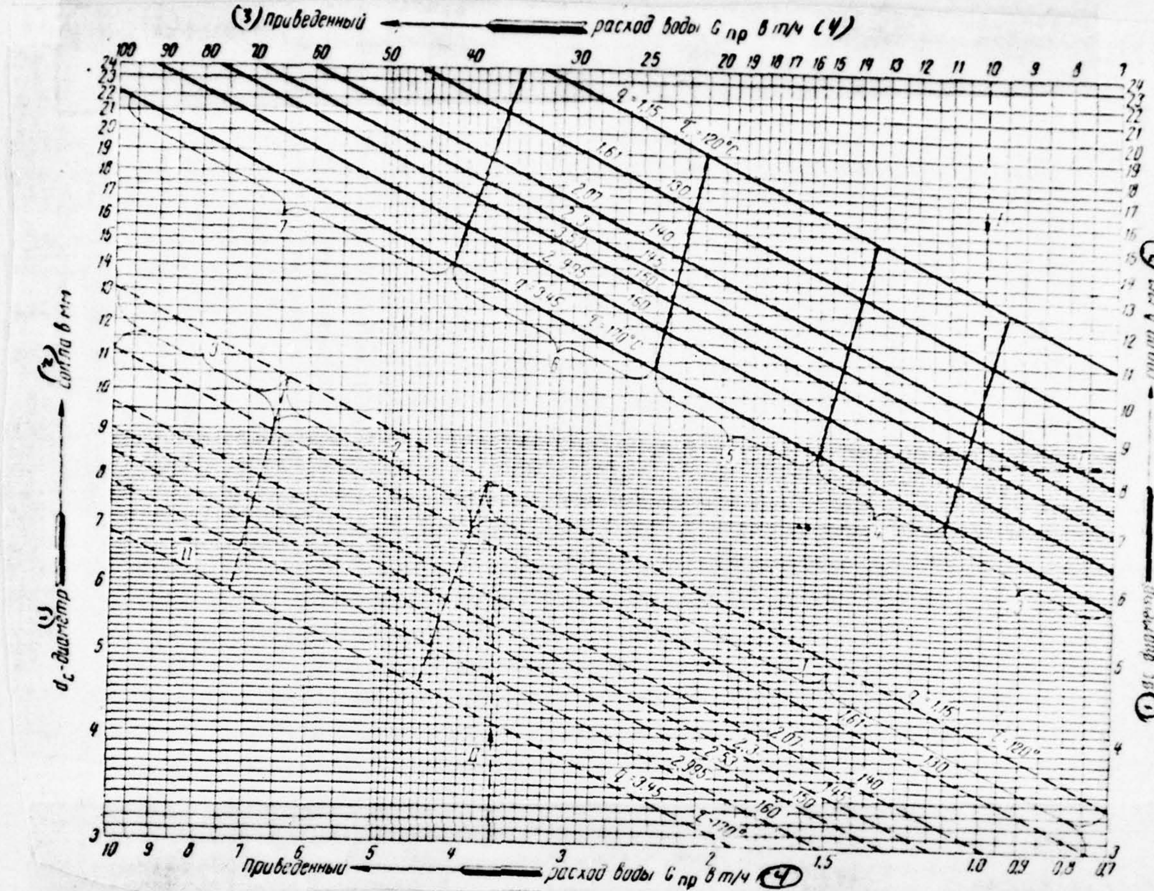

Fig. 19.6. Nomogram for determining diameter of nozzle.

Key: (1). Diameter. (2). nozzle in mm. (3). Reduced. (4). the consumption of water $G_{пр}$ in t/h.

Table 19.3. Technical characteristic and general data of pumps of TsNIIPS.

(1) Наименование	(2) Единица измерения	(3) По данным ЦНИИПС-10	(4) По данным ЦНИИПС-20
(5) Производительность .	$м^3/ч$ (6)	10	20
Напор общий (7).	м вод. ст. (8)	1,5	1,5
Число оборотов (9).	об/мин (10)	1440	1440
Мощность на валу (11)	квт (12)	0,12	0,23
Наружный диаметр (13) колеса	мм	105	105
Тип электродвигателя (14)	--	АОЛБ-31-4 Ф2	АОЛБ-32-4м Ф2
Мощность электродвигателя (15) . . .	квт (16)	0,27	0,4
Рабочее давление (17)	кгс/см² (18)	5	5
Диаметры патрубков (19) нагнетательного и всасывающего . . .	мм	80	80
Вес . . . . . (20).	кг (21)	65	65
Габариты: (22) длина, ширина, высота . . (23). . .	мм	505×235×245	505×235×245
Род тока—переменный однофазный (24)	в (25)	220	220

Key: (1). Designation. (2). Unit of measurement. (3). According to data TsNIIPS-10. (4). According to data TsNIIPS-20. (5). Productivity. (6). m^3/h. (7). Pressure is common/general/total. (8). m H_2O. (9). Speed. (10). r/min. (11). Shaft horsepower. (12). kW. (13). Outside diameter of wheel. (14). Type of electric motor. (15). Power of electric motor. (16). kW. (17). Operating pressure. (18). kg/cm². (19). Diameters of branch connections plenum and suction. (20). Weight. (21). kg. (22). Dimensions. (23). length, width, height/altitude. (24). The kind of current is alternating/variable single-phase. (25). V.

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Table 19.4. Basic schematic diagrams of the connection of local systems to thermal networks and of the condition of their application/use.

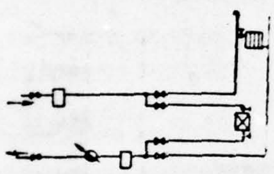
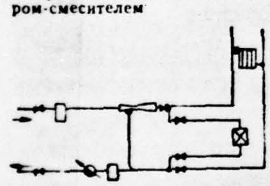
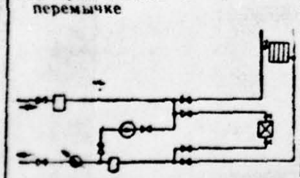
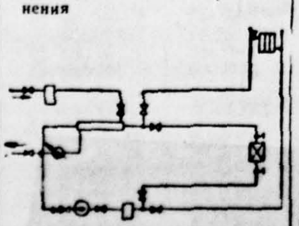
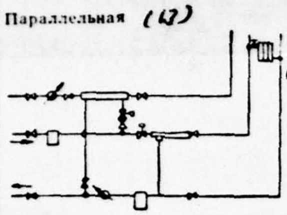
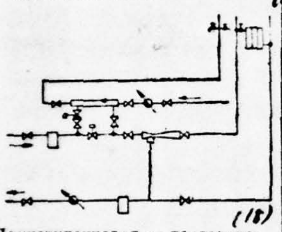
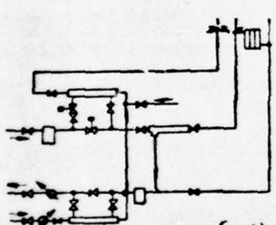
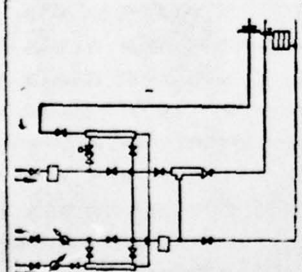
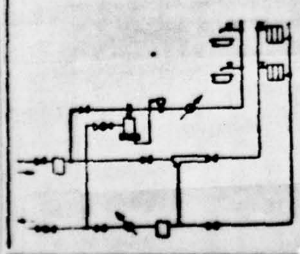
Принципиальная схема присоединения и ее наименование (1)	(2) Условия применения
1	2
Местные системы отопления и вентиляции (3)	
(4) Непосредственная без смесительных устройств 	(5) Для систем отопления промышленных зданий, бань, прачечных, спортивных залов, бассейнов, торговых помещений, зданий общественного питания объемом 500 $м^3$ и более и систем вентиляции при расчетной температуре в тепловых сетях до 150° С, а также для систем отопления и вентиляции жилых и общественных зданий и бытовых помещений промышленных зданий при расчетной температуре в тепловых сетях до 105° С
(6) Непосредственная с элеватором-смесителем 	(7) Для систем отопления жилых и общественных зданий, бытовых помещений промышленных зданий при расчетной температуре в тепловых сетях 150° С; для систем отопления промышленных зданий и систем вентиляции отдельных зданий при необходимости снижения температуры воды, поступающей в местную систему. Применяется при потере давления в местной системе до 1,5 *м вод. ст.*
(8) Непосредственная с насосом на перемычке 	(9) Для тех же условий, что и с элеватором-смесителем, но при недостаточности располагаемого напора для работы элеватора или при потере давления в местной системе более 1,5 *м вод. ст.*
(10) Независимая схема присоединения 	(11) Для систем отопления и вентиляции при давлении в подающем трубопроводе выше статического в местной системе, при давлении в обратном трубопроводе выше допустимого для местной системы, при недостаточности располагаемого напора для работы элеватора-смесителя, для зданий с высотой более 60 *м*, при присоединении к тепловым сетям с расчетной температурой в подающем трубопроводе выше 150° С

Table 19.4 continued.

(12) **Местные системы горячего водоснабжения**	
Параллельная (13) 	(14) **Закрытая система тепловых сетей** Для жилых, общественных и промышленных зданий независимо от соотношения максимального часового расхода тепла на горячее водоснабжение $Q^{макс}_{г.в}$ и отопления $Q_{от}$. К преимущественному применению рекомендуется при $\frac{Q^{макс}_{г.в}}{Q_{от}} > 1$, а также для небольших зданий с суммарным расходом тепла на отопление до 150—200 тыс. *ккал/ч* и для промышленных потребителей с количеством душевых сеток до 5
Предвключенная (16) 	(17) Для жилых и общественных зданий при $\frac{Q^{макс}_{г.в}}{Q_{от}} < 0{,}1$
(18) Двухступенчатая — последовательная 	(19) Для жилых, общественных и промышленных зданий при $0{,}3 < \frac{Q^{макс}_{г.в}}{Q_{от}} < 0{,}8$
(20) Двухступенчая — смешанная 	(21) Для жилых, общественных и промышленных зданий независимо от соотношения максимального часового расхода тепла на горячее водоснабжение $Q^{макс}_{г.в}$ и отопления $Q^{макс}_{г.в}$. К преимущественному применению рекомендуется при $\frac{Q^{макс}_{г.в}}{Q_{от}} > 0{,}8$
(22) **Непосредственный водоразбор из тепловой сети** 	(23) **Открытая система тепловых сетей для жилых, общественных и промышленных зданий независимо от соотношения нагрузок**

Key: (1). Schematic diagram of connection and its designation. (2). Application/use conditions. (3). Local heating systems and ventilation. (4). Direct without mixing devices. (5). For the heating systems of industrial buildings, baths, laundry, sport halls, basins, commercial locations, buildings of public nutrition by volume 500 m^3 and more and ventilation systems at the calculated temperature in thermal networks to 150°C, and also for the heating systems and ventilation of habitable and public buildings and everyday locations of industrial buildings at the calculated temperature in thermal networks to 105°C. (6). Direct with elevator-mixer. (7). For the heating systems of habitable and public buildings, everyday locations of industrial buildings at the calculated temperature in thermal networks 150°C; for the heating systems of industrial buildings and ventilation systems of separate buildings if necessary for a reduction/descent in the temperature of water, which enters the local system. Is applied with loss of pressure in local system to 1.5 m water column. (8). Direct with pump during cross connection. (9). For the same conditions that and with elevator-mixer, but with insufficiency of the available pressure for operation of elevator or with loss of pressure in local system are more than 1.5 m water column. (10). Independent

circuit of connection. (11). For the heating systems and ventilation at a pressure in delivery pipe, it is higher than static in local system, at a pressure in return line higher than permissible for a local system, with in sufficiency of available pressure for the work of the elevator of mixer, for buildings with height/altitude is more than 60 m, during connection the thermal networks with the calculated temperature in delivery pipe above 150°C. (12). Local systems of hot water supply. (13). Parallel. (14). Closed system of thermal networks. (15). For residential, public and industrial buildings independent of the relationship/ratio of the maximum hourly consumption of heat for hot water supply $Q_{г.з}^{макс}$ and heating $Q_{от}$. To preferred application/use it is recommended when $\frac{Q_{г.в}^{макс}}{Q_{от}} > 1$, and also for small buildings with total heat consumption for heating to 150-200 thousand, kcal/h and for industrial users with quantity of shower systems up to 5. (16). Connected in series. (17). For residential and public buildings with. (18). Two-stage is consecutive. (19). For residential, public and industrial buildings with. (20). Two-stage - mixed. (21). For residential, public and industrial buildings independent of the relationship/ratio of the maximum hourly consumption of heat for hot water supply $Q_{г.в}^{макс}$ and heating $Q_{г.в}^{макс}$. To preferred application/use it is recommended with. (22).

Direct water selection from thermal network. (23). The open system of heat networks for residential, public and industrial buildings regardless of the relationship/ratio of loads.

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Table 19.5. Duration of charge of batteries depending on the number of shower grids.

(1) Число душевых сеток	(2) Число часов зарядки аккумуляторов в смену
(3) До 5	(4) Не устанавливается
6—20	2
21—30	3
31 и более (5)	4—6

Key: (1). Number of shower grids. (2). Number of hours of the charge of batteries to replacement. (3). To. (4). It is not establish/installed. (5). and more.

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Section V.

HEAT CONTROL AND AUTOMATION OF THERMAL NETWORKS.

Chapter 20.

HEAT CONTROL AND AUTOMATION.

20.1. Heat control of thermal networks.

Heat control encompasses all component/links of the systems of heat supply (heat and power plant or boiler, thermal network with pumping and the thermal point/items of users) and includes the measurement of the temperatures of heat carrier and air, pressure of heat carrier, coolant flow rate, level of water and condensate in tanks, and also the salinities of condensate, of makeup water and network water.

AD-A066 415 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 13/2
DESIGNER'S HANDBOOK - INSTALLING THERMAL PIPE-LINE SYSTEMS. PAR--ETC(U)
FEB 78 I P ALEKSANDROV, I V BELYAYKINA
UNCLASSIFIED FTD-ID(RS)T-0094-78-PT-3

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The indicated values are measured with the aid of the showing, recording and summing heat-measuring, and also signalling instruments.

The designations of basic values and the conditional image of measuring meters and regulators, used in the circuits of heat control and automation are given by table 20.1.

Basic data on the produced by industry instruments for the measurement of temperatures and pressures are given in tables 20.2, 20.3 and 20.4.

In thermal networks predominantly are applied the showing thermometers and the manometers.

Recording thermometers and manometers are applied in the thermoficated installations of heat and power plant or in of boiler, and also in the central thermal point/items water and steam networks.

Thermal alarms, thermometers manometric electric-contact and pressure indicators are utilized in automation systems.

For providing the high accuracy of the measurement of temperatures, sometimes are applied the self-balancing potentiometers, which utilize predominantly for a work in assembly with thermocouples, and the automatic balanced bridges which in essence are utilized for a work with resistance thermometers.

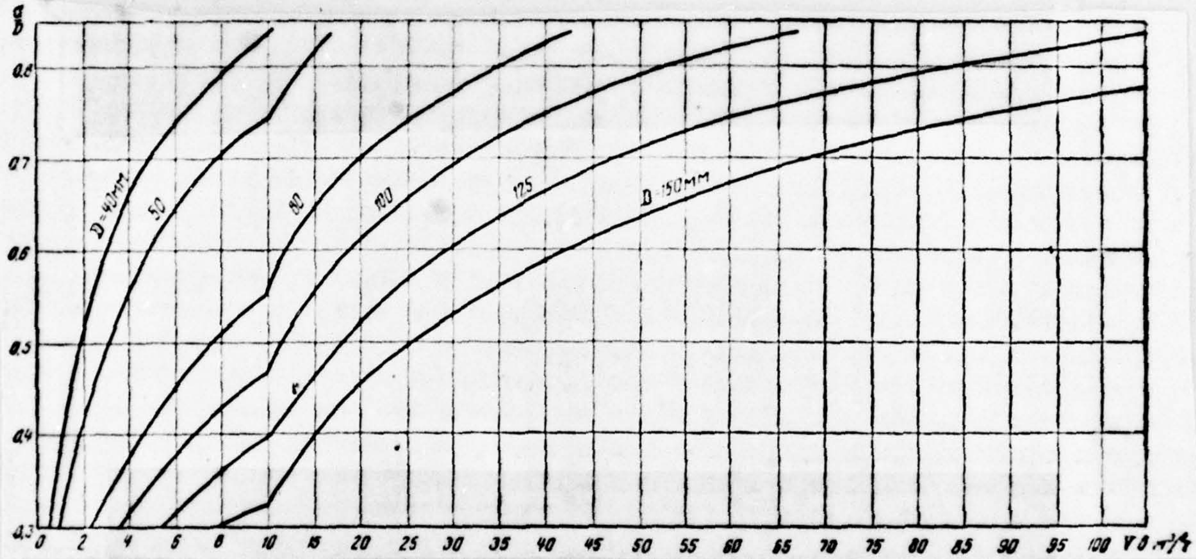

Fig. 20.1. Graph for determining diameter of throttle washer to heat-counter TS-1. D - diameter of conduit/manifold; d - diameter of throttle washer; V is minimum complete consumption of network water. Example. Is given: D = 50 mm and V = 6 m^3/h. On curve/graph d/D = 0.645; d = 0.645 D= 0,645·50=32,3 mm.

Key: (1) m^3/h.

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Table 20.1. Conditional images of measuring meters and regulators in the circuits of heat control and automation.

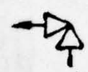
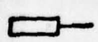
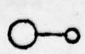
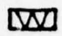
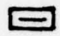
Условное изображение (1)	Наименование (2)
	Задвижка (3)
	Клапан обратный (4)
	Клапан регулирующий (5)
	Клапан предохранительный (6)
	Стеклянный термометр расширения (7)
	Термометр сопротивления (8)
	Термобаллон манометрического термометра (9)
	Термометр дилатометрический или биметаллический (10)
	Термосигнализатор, термометр (общее обозначение) (11)
	Отборное устройство давления, уровня (12)
	Приемное устройство концентратомера (13)
	Приемное устройство поплавкового уровнемера (14)
	Водосчетчик (15)
	Суживающее устройство для измерения расхода по перепаду (16)
	Сосуд конденсационный (17)
	Сосуд разделительный или уравнительный (18)

Table 20.1 continued.

	Прибор измерительный (19)
	Прибор регулирующий (сигнализирующий) (20)
	Прибор измерительный и регулирующий (сигнализирующий) в одном корпусе (21)
	Электрический вид передачи дистанционного воздействия (22)
	Механический вид дистанционной передачи (23)
	Ключ управления (24)
	Амперметр (25)
	Трансформатор тока (26)
МП	Пусковое устройство (27)
	Электродвигатель (28)
	Кнопка управления (29)
РВР	Реле включения резерва (30)
РВ	Реле времени (31)
	Лампа сигнальная (32)
	Звонок (33)

Key: (1). Conditional image. (2). Designation. (3). Catch. (4). Valve is reverse/inverse. (5). Valve controlling. (6). Valve is safety. (7). Glass thermometer of expansion. (8). Resistance thermometer. (9). Thermal bulb of manometric thermometer. (10). Thermometer dilatometric or bimetallic. (11). Thermal alarm, thermometer (general designation). (12). Choice device of pressure, level. (13). The receptor of concentration meter.

(14). The receptor of float level gauge. (15). Water meter. (16). Constricting device for the measurement of consumption on jump/drop. (17). Vessel is condensation. (18). Vessel separating or equalizing. (19). Instrument measuring [1].

FOOTNOTE [1]. In the upper part of the conditional image, is record/written the measured value; t is temperature; p - pressure; G - consumption; H - level; C - concentration (is allow/assumed to enter the chemical formula of substance).

In lower part is record/written the designation/purpose of the instrument: P - showing; S - recording; I - integrating; Sg - signalling; Sm - totalling (algebraic

sum), So - mastering relationship/ratio; Pz - position; Zd - assigning. ENDFOOTNOTE.

(20). Instrument controlling (signalling). (21). Instrument measuring and controlling (signalling) in one housing. (22). Electrical transmission mode of remote effect. (23). Mechanical form of teletransmission. (24). Key/wrench of control. (25). Ammeter. (26). Current transformer. (27). Starter. (28). Electric motor. (29). Control knob. (30). Relays of the start of reserve. (31). Time relays. (32). Tube is signal. (33). Bell.

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Table 20.2. Basic instruments for temperature measurement.

(1) Тип прибора	(2) Наименование	(3) Пределы измерения в °C		(4) Давление среды в кгс/см²
		(5) нижний	(6) верхний	
	Термометры стеклянные (7)			
ТТ	Ртутные технические (8)	0	50, 100, 150, 200, 250, 300, 350, 400	—
ТК-6 ТК-8	(9) С магнитной перестановкой контакта	0 50 100 200	50, 100, 150, 200, 300	— — — —
ТК-5	(10) С постоянными впаянными контактами	0	50, 100, 200, 300	— —
	Термометры манометрические газонаполненные (11)			
ТПГ-180	(12) Показывающие (без дополнительных устройств)	0	100, 120, 160, 200 250, 300,	64
ТСГ-710Мч	(13) Самопишущие на одну точку измерения с часовым приводом	20	120	•
ТСГ-710М	(14) Самопишущие на одну точку измерения с электроприводом	40 50	160, 200, 250, 300	• •
	(15) Термометры манометрические электроконтактные			
ЭКТ	(16) Паровые показывающие с двухконтактным устройством	−20 0 50 60 100	+40 60, 100, 150, 200 250	25 • • • •
ЭКТ	(17) Газовые показывающие с двухконтактным устройством	0	300	40
	(18) Термометры сопротивления			
ЭТМ-X, ЭТМ-XI	(19) Медные с неподвижным штуцером	−50	+100	40
ЭТМ-XIV	(20) Медные с передвижным штуцером	−50	+100	—
ЭТМ-XII	(21) Медные для измерения температур в помещениях	−50	+100	—
ЭТП-I,	(22) Платиновые с неподвижным штуцером одинарные	0	+500	40
ЭТП-VIII	То же, двойные (23)	0	+500	40
ЭТП-III	Платиновые с передвижным штуцером (24)	0	+500	—
ЭТП-IX	То же, двойные (25)	0	+500	—
	Термопары (26)			
ТХК-VIII	**Хромель-копелевые (27)**	−50	+600	30
ТХК-XIII	• •	−50	+600	—

Key: (1). Type of instrument. (2). Designation. (3). Capacities in °C. (4). Pressure of medium in kg/cm². (5). lower. (6). upper. (7). Thermometers are glass. (8). Mercury technical. (9). With the magnetic rearrangement of contact. (10). With the constant soldered contacts. (11). Thermometers manometric gas-filled. (12). Showing (without of the additional devices). (13). Recording to one measuring point with hour drive. (14). Recording to one measuring point with electric drive. (15). Thermometers manometric electric-contact. (16). Steam showing with double-contact device. (17). Gas showing with double-contact device. (18). Resistance thermometers. (19). Copper with fixed branch. (20). Copper with movable branch. (21). Copper for the measurement of the temperatures in locations. (22). Platinum with fixed branch single. (23). The same, double. (24). Platimum with movable branch. (25). The same, double. (26). Thermocouples. (27). Chromel-Copel.

Table 20.3. Basic electrical instruments for temperature measurement.

(1) Тип прибора	(2) Наименование	(3) Класс приборов
	(4) Милливольтметры (для работы в комплекте с термопарами)	
МПЩПр-54	(5) Показывающие, профильные	1,5
МПЩПл-54	(6) То же, для работы только с хромель-копелевыми (или хромель-алюмелевыми) термопарами	1,5
МСЩПр-154 МСЩПр-354 МСЩПр-654	(7) Самопишущие для измерения и записи температур соответственно в одной, трех или шести точках измерения	1,5
	(8) Логометры	
ЛПр-53 (ЛПБ-46)	(9) Магнитоэлектрические, показывающие, профильные для работы с медными (или платиновыми) термометрами сопротивления	1,5

Key: (1). Type of instrument. (2). Designation. (3). Class of instruments. (4). Millivoltmeters (for a work in assembly with thermocouples). (5). Showing, shaped. (6). The same, for a work only with Chromel-Copel (or chromel-alumel) thermocouples. (7). Recording for measurement and recording of the temperatures respectively in one, three or six measuring points. (8). Logometers. (9). Magnitoelectric, that show, shaped for a work with copper (or platinum) resistance thermometers.

Table 20.4. Basic pressure measurement devices.

Тип (1)	(2) Наименование	(3) Верхний предел показаний в кгс/см²
	(4) **Манометры с одновитковой трубчатой пружиной**	
ОБМ-100, ОБМ-160	(5) Технические манометры в корпусах диаметром 100 и 160 мм:	
	(6) класс точности 2,5 " " 1,5	4, 6, 10, 16 и 25
М-250	(7) Технические манометры в корпусе диаметром 250 мм, класс точности 1,5	10, 16, 25
	(8) **Манометры с многовитковой трубчатой пружиной**	
МСТМ-410, МСТМ-610	(9) Самопишущие с часовым и электрическим приводами без дополнительных устройств	
МГ-278, МСТМ-618	(10) С трехконтактным устройством показывающие и самопишущие	6, 10, 16, 25
МСТМ-430, МСТМ-630	(11) Самопишущие на две кривые с часовым и электрическим приводами	
МУЭ	(12) Показывающие с электрической дистанционной передачей	6, 10, 16, 25
	(13) **Сигнализаторы давления**	
РДС	(14) Сигнальное реле давления с одновитковой трубчатой пружиной с диапазоном настройки 3—25 кгс/см²	25

Key: (1). Type. (2). Designation. (3). The upper limit of readings in kg/cm². (4). Manometers with single-turn tubular spring. (5). Technical manometers in housings by diameter 100 and 160 mm. (6). the class of precision 2.5. (7). Technical manometers in housing by diameter 250 mm, the class of precision 1.5. (8). Manometers with multiturn tubular spring. (9). Auto/self-squeaking with hour and

electric drives without additional devices. (10). With three-pronged device showing and recording. (11). Recording to two curves with hour and electric drives. (12). Showing with electrical teletransmission. (13). Pressure indicators. (14). Signal pressure relay from single-turn tubular spring with tuning range 3-25 kg/cm².

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For the measurement of consumption the pair and the increased consumption of water (usually more than 40-100 t/hs) in the thermoficated installations of heat and power plant or boiler rooms, in locations of pumping and in thermal point/items establish/installs the differential manometers (table 20.5), connected to throttle devices (diaphragms). During the measurement of the consumption pair with the variable parameters in addition to differential manometer must be additionally establish/installed the manometer and thermometer for determining the specific gravity/weight of the medium taking place.

In the teletransmission of readings of differential manometers and manometers of the type MUE, apply secondary

instruments (table 20.6).

In the thermal point/items of the users of the water networks of low and average power the consumption of water usually is measured with the aid of hot-water water meters. The water meters are selected on table 20.7. The heat consumption in this case determines by the multiplication of readings of water meter by an average difference in the temperatures of feeding and return lines.

Is more perfect the account of heat distribution to the users of water thermal networks with the aid of heat-counters.

Mechanical heat-counter TS-1 includes common high-speed/velocity water meter and thermometric part (strictly heat-counter). A nominal error in the heat-counter with a difference in the temperatures from 20 to 100°C does not exceed ±4o/o (without taking into account of an error in water meter).

For providing the necessary passage of water on the pulse tubes of heat-counter in feeding and return lines, is establish/installed throttle washers.

The selection of the diameter of throttle washers for heat-counters TS-1 can be produced on curve/graph d/D = f(V, D) (Fig. 20.1).

The signal indicators of level, which are scale-less instruments, are intended for a work in the circuits of technological signaling or protection condensate and drainage pumping (table 20.8).

Instruments PSh, PF, PK are produced each in two modifications: SU-4 - for nonexplosive conditions and SUVZG-4 - for explosion- and flammable conditions.

Table 20.5. Basic instruments for the measurement of consumption on the pressure differential.

(1) Тип прибора	(2) Наименование	(3) Пределы показаний
ДТ-50	(4) Дифференциальные манометры двухтрубные стеклянные на 50 кгс/см²	700 мм
	(5) Дифференциальные манометры поплавковые механические с ртутным заполнением	
	(6) Без дополнительных устройств:	
ДП-280	показывающие (7)	
ДП-410	(8) самопишущие с часовым приводом	(9)
ДП-610	(10) самопишущие с электрическим приводом	Расчетные перепады 40, 63, 100, 160 250 400, 630, 1000 мм рт. ст.
ДП-281М	(11) Показывающие с интегратором	(12) Шкала от 0 до 100, 125, 160, 200, 250, 320, 400, 500, 630, 800 единиц расхода с поправочным множителем 10^n, где n — любое целое положительное или отрицательное число
ДП-612М	(13) Самопишущие с интегратором, отметчиком и электрическим приводом	
ДЭМП-280	(14) С электрической дистанционной передачей показаний	
	(15) Самопишущие с дополнительной записью давления:	
ДП-430	с часовым приводом (16)	
ДП-630	с электрическим приводом (17)	
ДПЭС	Поплавковые бесшкальные (18) для работы с одним или двумя вторичными приборами	(19) Расчетные перепады 40, 63, 100, 160, 250, 400, 630, 1000 мм рт. ст.
	(20) Дифференциальные манометры мембранные	
ДМ	Бесшкальные (21)	(22) Расчетные перепады 40, 63, 100, 160, 250, 400, 630, 1000 мм рт. ст.

Key: (1). Type of instrument. (2). Designation. (3). Limits of readings. (4). Differential manometers two-funnelled glass to 50 kg/cm². (5). Differential manometers float mechanical with mercury filling. (6). Without additional devices. (7). showing. (8). recording with hour drive. (9). Calculated jump/drops 40, 63, 100, 160, 250, 400, 630, 1000 mm Hg.

(10). recording with electric drive. (11). Showing with integrator. (12). The scale from 0 to 100, 125, 160, 200, 250, 320, 400, 500, 630, 800 units of consumption with correction factor 10^n, where n is any positive integer or negative number. (13). Recording with integrator, marker and electric drive. (14). With the electrical teletransmission of readings. (15). Auto/self-squeaking with additional recording pressures. (16). with hour drive. (17). with electric drive. (18). Float scale-less for a work with one or two secondary instruments. (19). Calculated jump/drops 40, 63, 100, 160, 250, 400, 630, 1000 mm Hg. (20). Differential manometers are membrane/diaphragm. (21). Scale-less. (22). Calculated jump/drops 40, 63, 100, 160, 250, 400, 630, 1000 mm Hg.

Table 20.6. Secondary electrical instruments to the manometers MUE and float differential manometers DEPM-280 and DPES.

(1) Тип прибора	(2) Вторичные приборы
Э-280, Э-610	(3) Без дополнительных устройств показывающие и самопишущие
Э-231М, Э-612М	(4) С интегратором показывающие и самопишущие
Э-278, Э-618	(5) С электрическим контактным устройством показывающие и самопишущие
Э-630	(6) Самопишущие с дополнительной записью давления

Key: (1). Type of instrument. (2). Secondary instruments. (3). Without additional devices showing and recording. (4). With integrator showing and recording. (5). With electrical contact device showing and recording. (6). Recording with additional recording pressures.

Table 20.7. Fundamental characteristics of water meters with a vertical impeller of the type VK and a horizontal revolving door of the type VV.

(1) Тип водосчетчика	(2) Калибр в мм	(3) Характерный расход в м³/ч	(4) Допустимая нагрузка в м³/ч			
			(5) наименьшая	(6) непрерывная работа	(7) при работе 10 ч в сутки	(8) кратковременная
ВК-3	15	3	0,26/0,2	0,35/0,5	0,42/0,6	1,05/1,5
ВК-5	20	5	0,36/0,26	0,56/0,8	0,7/1	1,75/2,5
ВК-10	30	10	0,52/0,4	1,2/1,7	1,4/2	3,5/5
ВК-20	40	20	1,04/0,8	2,3/3,3	2,8/4	7/10
ВВ-50	50	70	5/3,5	8/13	10/16	20/35
ВВ-70	80	250	10/5	25/46	30/55	60/110
ВВ-100	100	440	20/7	42/73	50/87	100/175
ВВ-150	150	1000	40/10	104/158	125/190	250/380

Key: (1). Type of water meter. (2). Caliber in mm. (3). Characteristic consumption in m²/h. (4). Permissible load in m³/h. (5). smallest. (6). continuous operation. (7). in 10 h in a 24 hour period. (8). short-term.

Note. The numerals, which stand in numerator, are related to hot-water water meter (with the metallic revolving door), in denominator - to cold water. (Given numerals tentative).

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20.2. Schematic diagrams of the automation of the basic nodes of thermal networks.

Automation of the feed of devices.

The automated feed devices maintain the constant or changing according to the specific law pressure of water at the point of the additional feeding of network. For thermal networks with relatively small losses of head in main lines and the favorable airfoil/profile of locality, the pressure at the point of additional feeding at all conditions/modes (including conditions/mode with the stationary network pumps) is supported by constant. The exemplary/approximate schematic diagram of heat control and automation of the additional feeding of closed thermal network is given in Fig. 20.2.

By circuit is provided the maintenance of constant

pressure in the reverse/inverse collector/receptacle before network pumps with the aid of pressure regulator "after itself" (regulator of additional feeding), establish/installed on the pipeline of makeup water.

In the case when the static pressure of thermal network exceeds pressure by reverse/inverse collector/receptacle of heat and power plant in the work of network pumps, rearrangement to static pressure is realize/accomplished by hand [1].

FOOTNOTE [1]. In this case possibly the application/use of special ~~I will eat~~ circuits (two-pulse, etc.), which ensure automatic rearrangement to static pressure. ENDFOOTNOTE.

The pressure of water measures in the forcing branch connections of makeup pumps with the local showing and signalling manometers, which give momentum/impulse/pulse on the inclusion of standby pump, and in reverse/inverse collector/receptacle - by showing, that record and by that signalling by manometers on local panel. On local panel is provided for also the setting up of the secondary

instrument of the showing, recording and signalling flow meter for the measurement of the consumption of additional water and secondary instrument of the recording and signalling oxygen analyzer for the measurement of the oxygen content in makeup water. Resistance thermometer on feed line they connect to common/general/total recording instrument, which records simultaneously the temperatures of network water.

In the open thermal networks during setting up at the station of central tank- storage battery/accumulators the pressure in return line regulates by automatically two control valves of which the first is establish/installed on the bypass line of surplus network water to beam- storage battery/accumulators, and by the second - on pipeline from tank- storage battery/accumulators after transfer pumps. The schematic diagram of heat control and automation of the additional feeding of the open thermal network is given in Fig. 20.3.

In the hours when the load of hot water supply is lower than daily mean, transfer pumps are opened, and pressure in return line is regulated by the first valve. In the hours when the load of hot water supply is higher

than daily mean, automatically are switched on transfer pumps, is closed first control valve, and pressure regulator is switched to control valve, installed after transfer pumps.

For providing constant flow rate/consumption of makeup water in the open thermal network on delivery conduit of makeup pumps, is establish/installed the flow regulator.

Water level in the deaerating tank of additional feeding is supported by control valve on the line of the chemically purified water.

If instead of the vacuum deaerator, working on the sliding pressure, will be used atmospheric, then additionally is establish/installed the regulator, which supports constant pressure in the column of deaerator (in Fig. 20.3 it is not shown).

Diagram provides for emergency shutdown of workers of feed and transfer pumps and the automatic breaking of standby, and also the signaling of pressure in return line of the level in the tank of the deaerator of additional feeding and tanks-accumulators of network water and oxygen

contents in feed zone. Resistance thermometer on feed line they connect to common/general/total recording instrument (analogous with the preceding/previous diagram).

Of taken in diagram in Fig. 20.3 electronic controllers can be replaced hydraulic.

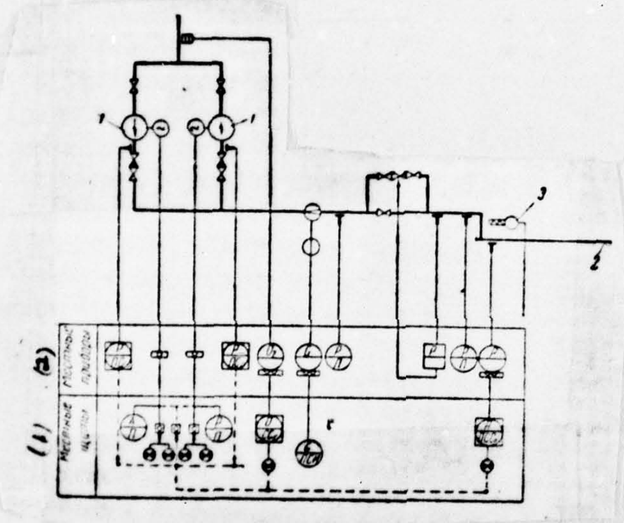
Table 20.8. Basic types of the signal indicators of level.

(1) Тип сигнализатора	(2) Наименование	(3) Рассчитаны на изменение уровня
ПШ	(4) Сигнализатор уровня поплавковый штуцерный	(5) До 365 мм
ПФ	(6) То же, фланцевый	» 365 »
ПК	(7) » камерный	(8) » 250 »
РП-40	Поплавковое реле (принципиально аналогично сигнализатору типа ПК) (9)	От 20 до 150 мм
РП-51	Поплавковое реле для установки в открытых резервуарах (10)	» 0,5 » 10 м

Key: (1). Type of signal indicator. (2). Designation. (3). Are designed for a change in the level. (4). Signal indicator of level float nozzle. (5). To 365 mm. (6). The same, flanged. (7). The same, chamber. (8). From 20 to 150 mm. (9). Float relay (similar in principle to a signal indicator of the type PK. (10). Float relay for setting up in the open reservoirs.

Fig. 20.2. Exemplary/approximate schematic diagram of heat control and automation of additional feeding of closed thermal network. 1 - makeup pumps; 2 - return line; 3 - resistance thermometer.

Key: (1). Local panels. (2). Local instruments.



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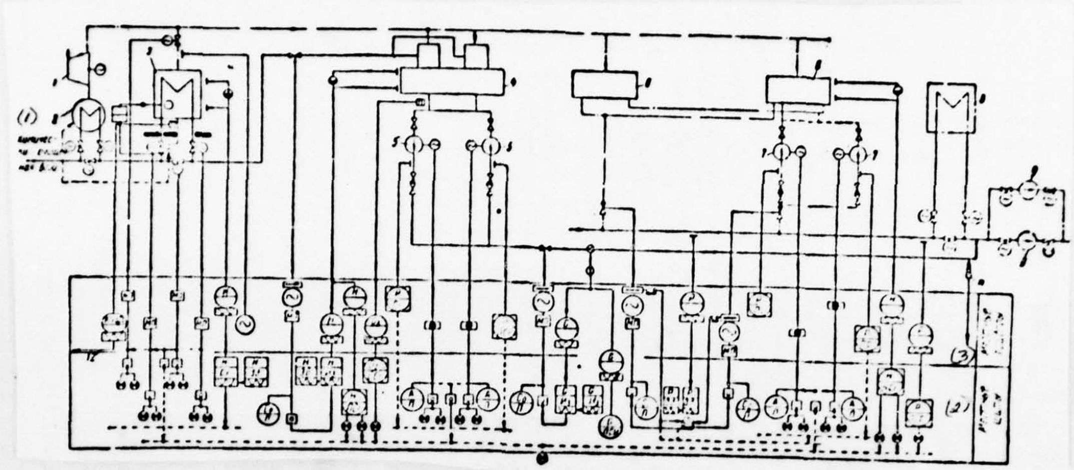

Fig. 20.3. Exemplary/approximate schematic diagram of heat control and automation of additional feeding of open thermal network. 1 - turbine; 2 - condenser/capacitor; 3 - preheater of additional feeding; 4 - vacuum deaerator; 5 - makeup pumps; 6 - tank- storage battery/accumulators; 7 - transfer pumps; 8 - network preheater; 9 - network pumps; 10 - return line of thermal network; 11 - resistance thermometer; 12 - line to the recording salinometer.

Key: (1). Chemically purified water. (2). Local panels. (3). Local instruments.

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Automation of network preheaters.

The assigned/prescribed temperature of network water after peak-load preheaters they support with the aid of temperature regulator because of throttling/choking of heating steam (Fig. 20.4). The temperatures of water in delivery pipe are assigned by hand according to dispatchers graph.

With increase of salt content or level of condensate with the breakage of pipes the corresponding preheater is automatically of disconnector.

The automatic temperature control of network water after basic preheaters (with switched off peak preheaters) should realize/accomplish by a bypass of the part of the water besides preheaters.

Automation of pumping.

The automation of the booster and mixing pumping thermal networks provides for in the volume, which ensures their normal and accident free operation without the constant presence of on duty personnel.

Automation of the booster pumping on delivery pipe it is usually provided for (Fig. 20.5) in the following volume:

a) blocking pumping units for the automatic breaking of standby pump with the emergency disconnection/cutoff of worker;

b) blocking the electric motor of pump and catch on its forcing branch connection for automatic closing of gate of working pump with its emergency cutoff and simultaneous opening of gate of standby pump upon his start (it is applied, when the launching/starting of pumps with the open

catch is not reccmmended).

c) the automatic breaking of standby pump with a pressure drop in the forcing branch connection of worker.

d) automatic changeover to standby power supply upon the disappearance of the voltage of basic power supply, for which feeding by electric energy of pumping is provided for two feeders from two independent sources (from ring or from two transformer points);

e) signaling about malfunction that which pumps pumping on local control board (excess to the released temperature in bearings, the automatic breaking of standby pump, decompression of water in supply pipeline after pumps and the excess of the tolerance level of water in drainage pit) and into the district control post of thermal network.

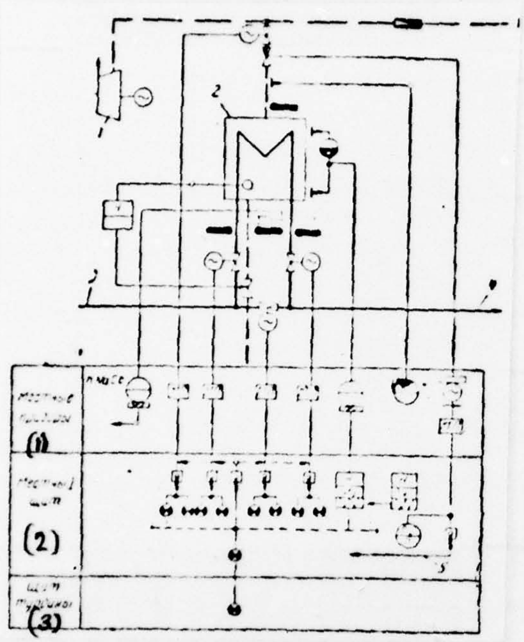

Fig. 20.4. Exemplary/approximate schematic diagram of heat control and automation of peak network preheater 1 - turbine; 2 - peak network preheater; 3 - pipeline from basic preheaters; 4 - delivery pipe; 5 - line to electronic temperature regulator of network water.

Key: (1). Local instruments. (2). Local panel. (3). Panel of turbine.

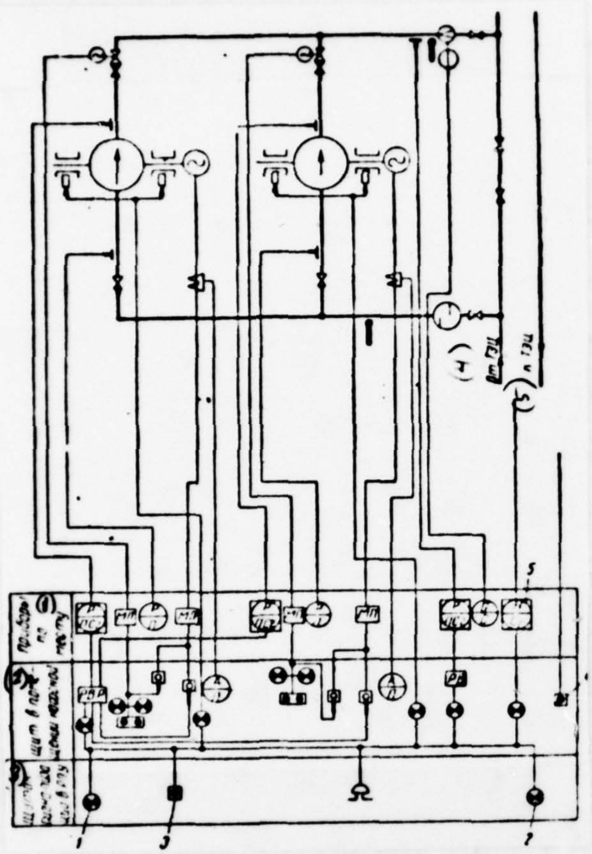

Fig. 20.5. Exemplary/approximate schematic diagram of heat control and automation by booster pumping on delivery pipe 1 - tube of signaling of malfunction in pumping; 2 - tube of signaling of normal operation of pump; 3 - knob/button of switching on of circuit of signaling and extinguishing of sound signal; 4 - knob/button of testing tubes; 5 - water level alarm in drainage pit.

Key: (1). Instruments on place. (2). panel in locations of pump. (3). Signalling board to RPU. (4). from TZTs. (5). to TZTs.

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In certain cases with the superheating of bearings, they are not limited only to signaling and is provided for the automatic disconnection/cutoff of working pump.

The exemplary/approximate schematic diagram of heat control and automation to the booster pumping on return line is represented in Fig. 20.6. This diagram is characterized by from the diagram of heat control and automation of pumping on delivery pipe by installation of the additional regulator which maintains constant pressure in the common/general/total inlet tubing.

To this same inlet tubing is connected signal device of pressure (on its common/general/total delivery conduit they are not establish/installed).

The diagram of heat control and automation by mixing

pumping (Fig. 20.7) provides for the setting up of temperature regulator, which supports the assigned/prescribed temperature of the mixed water after pumping by changing the quantity of mixed water from return line. The rearrangement of the controller of temperature regulator in the diagram in question manual; however, can be realized an automatic change in the assigned temperature of the mixed water depending on the temperature of surrounding air. In the remaining part the diagram of heat control and automation of mixing pumping is similar to the diagram, depicted in Fig. 20.5, with the exception of the fact that for mixing pumping we do not install the pressure indicator on common duct.

Automatic protection of water thermal networks.

The devices of the automatic protection of thermal networks from elevated pressure thus far still only begin to be introduced. Are at present several installations of protection with the application/use of hydraulic devices, made on the development of ORGRES.

The automatic protection of thermal network with the emergency disconnection of network pumps at station cuts thermal network to two independent zones: upper (with the increased static pressure) and lower (with the lowered/reduced static pressure).

Figures 20.8 gives the exemplary/approximate schematic diagram of the automatic protection of thermal network from pressure with the stop of network pumps for the case when the zone of increased static pressure is arrange/located from heat and power plant.

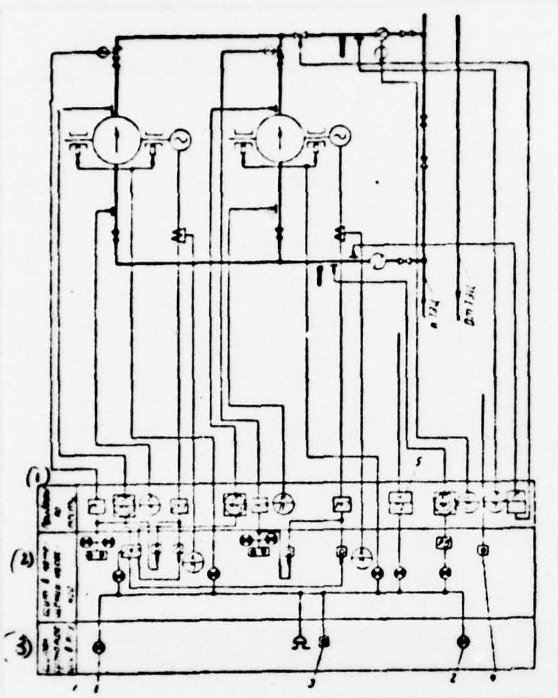

Fig. 20.6. Exemplary/approximate schematic diagram of heat control and automation by booster pumping on return line 1 - tube of signaling of malfunction in pumping; 2 - tube of signaling of normal operation of pumping; 3 - knob/button of switching on of circuit of signaling and extinguishing of sound signal; 4 - knob/button of testing tubes; 5 - water level alarm in drainage pit.

Keys Illigilble.

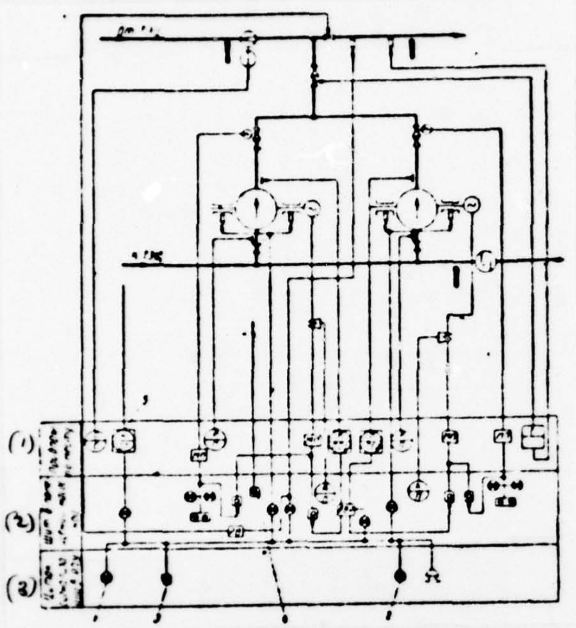

Fig. 20.7. Exemplary/approximate schematic diagram of heat control and automation by mixed pumping 1 - tube of signaling of malfunction in pumping; 2 - tube of signaling of normal operation of pumping; 3 - knob/button of switching on of circuit of signaling and extinguishing of audible signal; 4 - knob/button of testing tubes; 5 - water level alarm in drainage pit.

Keys Illigible.

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With a pressure increase in opposite line over assigned/prescribed, the automatic breaking machine is closed during 6-12 s and simultaneously is closed check valve.

The additional feeding of lower zone during the operation of the automatic breaking machine produces bypass of water and the reverse/inverse main line of upper zone into lower. The automatic control of additional feeding is realize/accomplished with the aid of two-pulse pressure regulator. Main impulse is pressure in return line of lower zone, and by enabling pulse - pressure in the delivery pipe of lower zone.

Automatic of the protection of thermal networks from elevated pressure with the stop of network pumps for the case when the zone of the lowered/reduced static pressure is arrange/located from heat and power plant, unlike diagram, examined above must additionally have makeup pumps. The sites of installation of automatic protection of thermal network it is expedient to unite with the booster and

mixing pumping, and also with the sites of installation of pressure regulators on return line of network.

Automation of the thermal point/items of water thermal networks.

For two-funnelled closed water thermal networks with the parallel connection of the preheaters of hot water supply, the automation of the thermal point/items of users (Fig. 20.9) solves the following problems: supports constant pressure in return line of heating systems for the high and highly placed buildings with the aid of pressure regulator (backwater); it supports constant flow rate/consumption of network water for a heating system with the aid of flow regulator (the pressure differential) during the application/use of ratio governing and considerable oscillation/vibration of pressure difference between feeding and return lines; it supports the constant temperature of the water, which enters the system of hot water supply (temperature of local water after preheater).

The diagram in question can be used as for the

elevator, so also pumping mixing of the thermal point/items of buildings, and also for central thermal point/items.

The automation of heating systems provides maintenance within the assigned/prescribed limits of the temperature of internal air. Developed for this purpose experimental designs of individual temperature regulators most completely solve assigned mission, but the setting up of large quantities of these regulators encounters considerable difficulties. A simpler, but also rougher method of the temperature control of internal air is the application/use of regulators of the local passages which establish/install in thermal point/items (in figure regulator it is not shown). In experimental design of this regulator of the type Thermal network of the Mosc power system Admin as momentum/impulse/pulse was accepted the internal temperature of one-two locations of the heated building; however, here can be accepted other solutions. The setting up of the regulators of local passages is especially advisable for the considerable duration of the period of the control of two-funnelled closed thermal network with constant minimum temperature of water in delivery pipe, and also in buildings without hot water supply in the case of the control of network on the increased temperature graph in the consecutive two-stage

circuit of hot water supply at the majority of users.

The exemplary/approximate diagram of heat control and automation of the thermal point/item of user with closed thermal network with the two-stage diagram (consecutive or mixed) of hot water supply is given in Fig. 20.10 upon the start of thermal point/item according to two-stage series circuit of the hot water supply of catch 7, 8, 9, 10 are opened, but 11, 12 are closed. Upon the start of thermal point/item according to the mixed diagram of the hot water supply of catch 7, 9, 10, 12, are opened, and 8, 11 are closed.

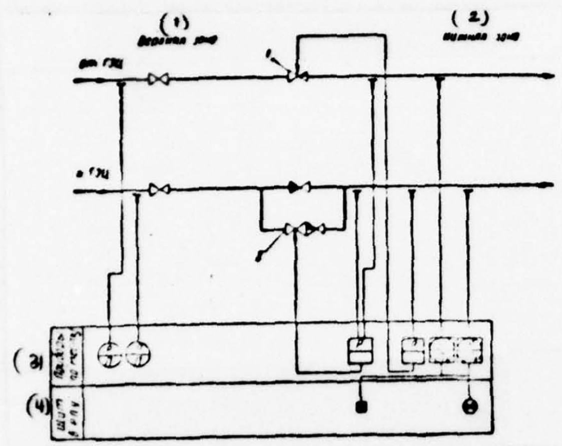

Fig. 20.8. Exemplary/approximate schematic diagram of automatic protection of thermal network from pressure with stop of network pumps 1 - automatic machine of crosscut; 2 - line of additional feeding of lower zone.

Keys Illigible.

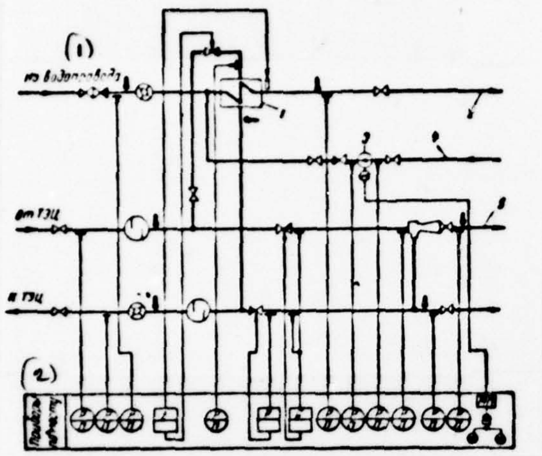

Fig. 20.9. Exemplary/approximate diagram of heat control and automation of thermal point/item of user with closed thermal network with parallel connection of preheaters of hot water supply. 1 - preheater of hot water supply; 2 - pipeline of local hot water; 3 - circulating pump; 4 - circulation pipeline; 5 - delivery pipe of heating system. 1n1 Key: (1). water pipe.

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The diagram of heat control and automation for the case in question virtually remains the same as for the thermal point/item of building with closed thermal network with the parallel connection of the preheaters of hot water supply.

For two-stage series circuit of hot water supply with the temperature control of water in delivery pipe on heating graph is developed additional device in the diagram of automation for a reduction/descent in the consumption of network water with a temperature decrease of surrounding air.

The exemplary/approximate diagram of heat control and automation of the thermal point/item of user with the open thermal network, working on the corrected temperature graph, is given in Fig. 20.11.

The diagram of automation in question provides the maintenance of constant flow rate/consumption of network water in the common/general/total delivery pipe of thermal point/item and constant temperature of the mixed water, which enters the system of hot water supply.

Low-pressure in the case in return line of thermal network, is necessary the setting up of pressure regulator (backwater) in the thermal point/item of user or in thermal network.

If in the open thermal network control is conducted with the alternating/variable consumption of water in the common/general/total delivery pipe, flow regulator on thermal point/item on is establish/installed.

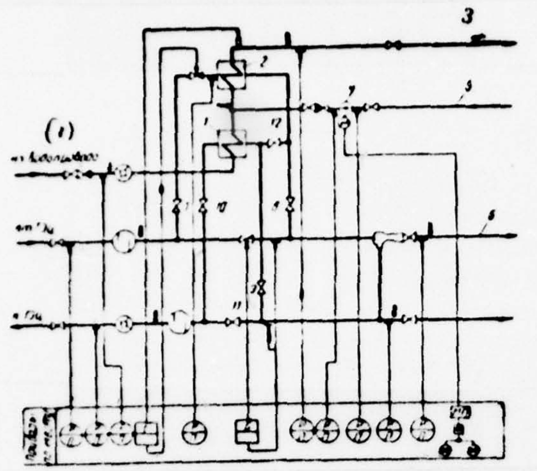

Fig. 20.10. Exemplary/approximate diagram of heat control and automation of thermal point/item of user with closed thermal network with two-stage diagram (consecutive or mixed) of hot water supply. 1 - step/stage 1 of heater of hot water supply; 2 - step/stage of II heater; 3 - pipeline of local hot water; 4 - circulating pump; 5 - circulation pipeline; 6 - delivery pipe of heating system; 7, 8, 9, 10, 11, 12 - catch.

Key Illigible.

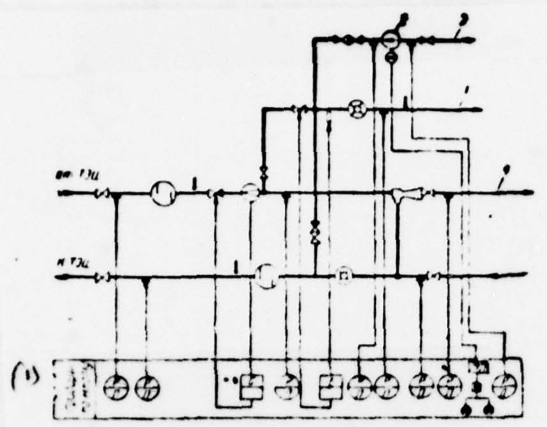

Fig. 20.11. Exemplary/approximate diagram of heat control and automation of thermal point/item of user with open thermal network 1 - pipeline of local hot water; 2 - circulating pump; 3 - circulation pipeline 4 - delivery pipe of heating system.

Key Illigible.

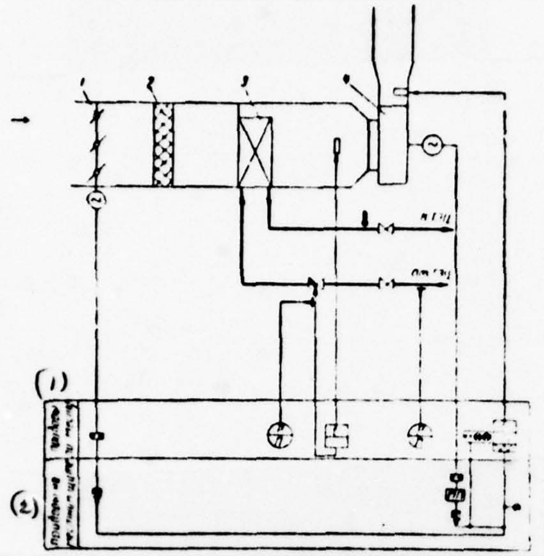

Fig. 20.12. Exemplary/approximate schematic of heat control and automation of supply ventilaticn camera/chamber. 1 - folding air valve; 2 - filter; 3 - heater; 4 - fan, which feeds is air into location.

Key Illigible.

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The exemplary/approximate diagram of plenum ventilation, given in Fig. 20.12, provides: the maintenance of the constant temperature of the air, supplied by fan into

location, by a change in the consumption of network water; the automatic cutout of fan and the coverage of folding air valve in the case of a temperature decrease of the air, which enters the location, below the assigned/prescribed minimum.

Automation of the thermal point/items cf the users of vapor and drainage pumping.

The basic tasks of the automation of the thermal point/items of users pair are the maintenance of constant pressure pair in users and control of the evacuation of condensate from the condensate tanks of steam users.

The exemplary/approximate schematic of heat control and automation of reduction setting up is given in Fig. 20.13. Pressure pair is supported at the assigned/prescribed level by inflow change pair with the aid of throttle valve.

The exemplary/approximate diagram of heat control and automation of condensate pumping in the closed circuit of collection and return of condensate is given in Fig. 20.14.

In the setting up in question they are provided for:

a) automatic activation of operating condensate pump on level 5 and standby - on upper level 4;

b) the automatic disconnection/cutoff of pumps on level 6;

c) the maintenance of the assigned/prescribed pressure of steam pillow in tank with the aid of pressure regulator;

d) the protection of condensate tanks from elevated pressure;

e) signaling on control room about the normal operation of pumping, and also about increased pressure in the tank, increased the salinity of condensate, to the elevated temperature of bearings and about the achievement by the condensate of upper level 4 or of lower level 7.

The closed diagrams of collection and return of condensate sometimes are fulfilled cooled of condensate in coolants and with automatic control of the temperature of

the water, heated by condensate (in figure shown).

The diagrams of heat control and automation of the open systems of collection and return of condensate do not have pressure regulator of steam pad', and in other respects they do not differ in principle from diagram examined above. The diagrams of heat control and automation by drainage pumping, given in Fig. 20.15, in principle is similar to the diagram of condensate pumping in the open system of collection and return of condensate. The automatic breaking of working pump occurs on level 4 and standby - on upper level 3, while the automatic disconnection/cutoff of pumps - on level 5. During of upper level 3 or of lower level 6, affects the signaling.

20.3. Basic types of regulators, applied in thermal networks.

The flow regulators of water of direct action of the type PP (Fig. 20.16a) are intended for maintaining constant flow rate/consumption of water (constant pressure differential) in the thermal point/items of buildings. By

sensing element and simultaneously the servodrive of regulator is steel bellows. Regulator housing is cast iron; the operating pressure 10 kg/cm²; the temperature of heat-introducer to 150°C.

Basic data on regulators of the type PP are given in table 20.9.

The selection of the flow regulators of direct action of the type PP is produced on table 20.10.

A regulator of the type PP can be used as control valve with bellows drive for pilot-actuateds regulator (temperature, pressures and consumption).

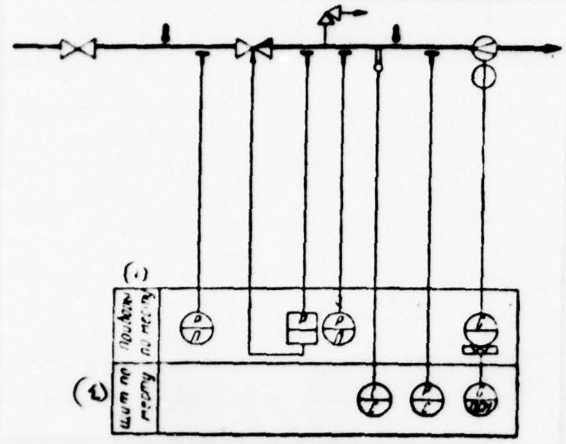

Fig. 20.13. Exemplary/approximate schematic of heat control and automation of reduction setting up.

Key: (1). Instruments on place. (2). sheet rubber on place.

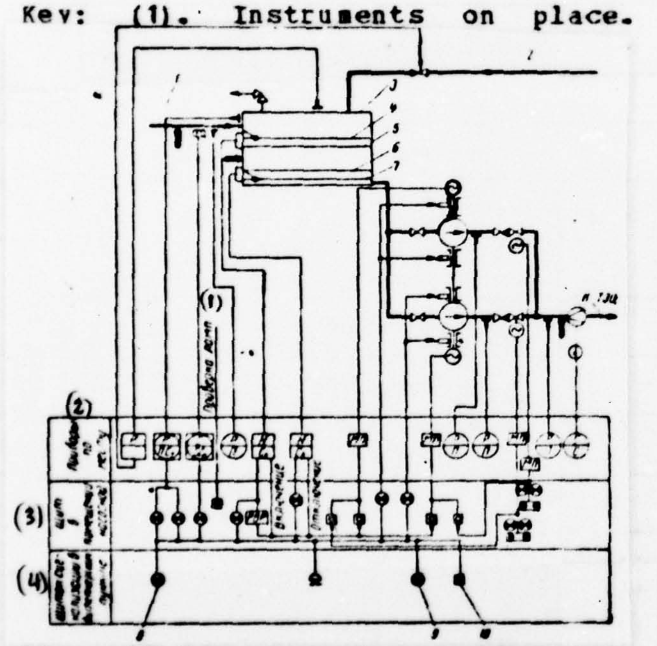

Fig. 20.14. Exemplary/approximate diagram of heat control and

automation of condensate pumping 1 - pipeline of condensate from production; 2 - steam line: 3 - condensate tank; 4-7 - levels of condensate; 8 - tube of signaling of malfunction in pumping, 9 - signaling lamp of normal operation of pumping; 10 - knob/button of switching on of circuit of signaling and extinguishing of sound signal.

Key: (1). Check of lamps. (2). instruments on place. (3). panel in location of pumping. (4). signalling panel to RPU. (5). start. (6). cutoff.

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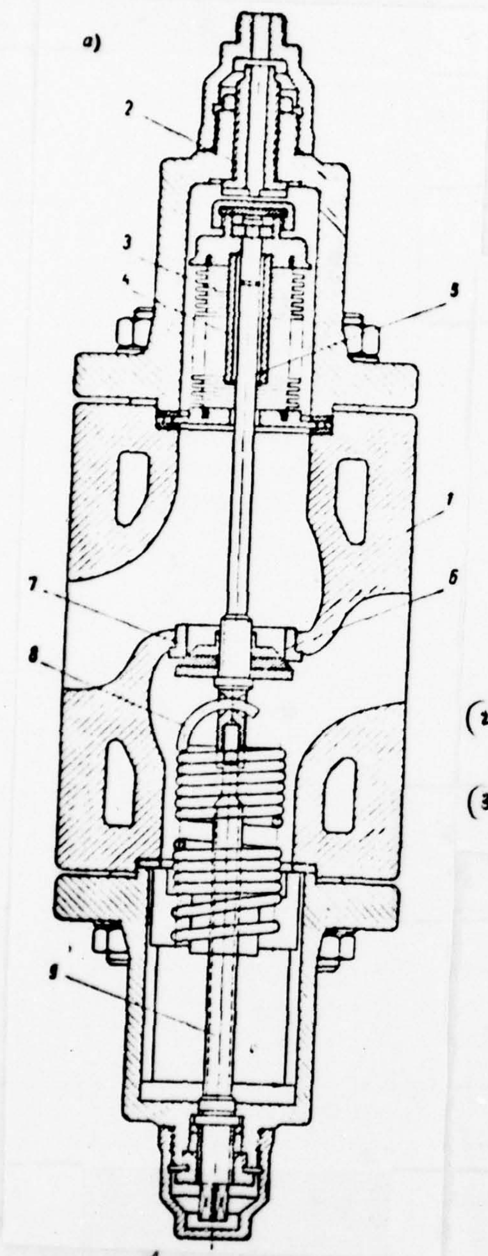

Fig. 20.15.

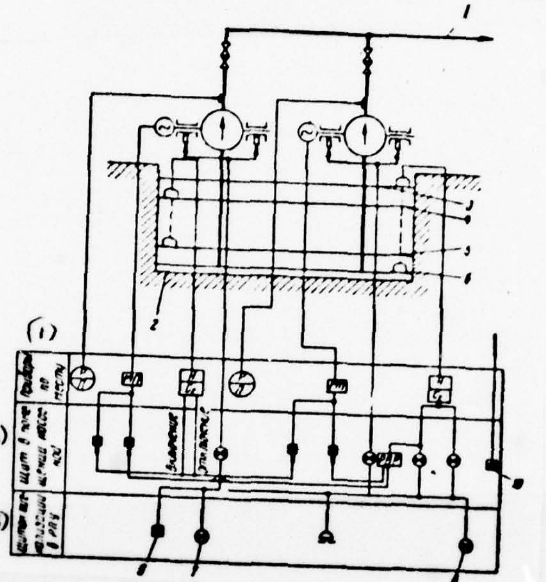

Fig. 20.15.

Fig. 20.15. Exemplary/approximate diagram of heat control and automation by drainage pumping. 1 - pipeline for the jettisoning of water into channelization or outside; 2 - drainage pit, 3, 4, 5, 6 - water levels; 7 - tube of the signaling of malfunction in pumping; 8 - tube of the signaling of the normal operation of pumping; 9 - knob/button of the switching on of the circuit of signaling and extinguishing of the sound signal; 10 - knob/button of testing tubes.

Keys Illigible.

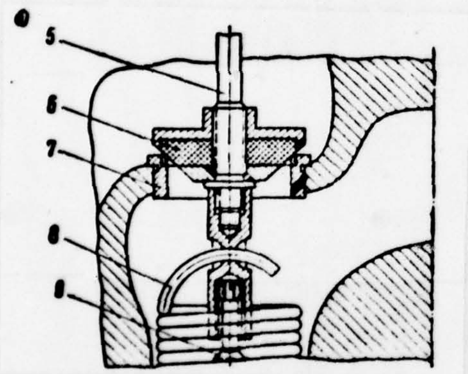

Fig. 20.16. Regulators with bellows drive. a) the flow regulators of water of direct action of the type PP; b) pressure regulators of direct action of the type RR; 1 - housing; 2 - limiter of the coverage of valve; 3 - bellows; 4 - catcher of valve; 5 - stock/rod; 6 - slide

valve (valve); 7 - saddle; 8 - spring; 9 - screw/propeller are tightening.

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In the closed state admission of valve, virtually is absent.

Pressure regulators (backwater) of direct action of the type RD (Fig. 20.16b) are intended for maintaining the constant pressure in return line of the thermal point/items of buildings (before regulator).

Pressure regulator of the type RD differs from the flow regulator of the type RR by the changed position of slide valve, by the absence of the limiter of the coverage of valve and by more hard spring.

Regulator housing cast iron; the operating pressure 10 kg/cm^2; the temperature of heat carrier to 150°C.

Pressure regulators of the type RD are produced by small batches with the diameter of the internal diameter 50

mm (diameter of the neck of saddle 44 mm) to the maximum adjustable pressure 5 kg/cm².

Nonuniformity 0.55-0.75 kg/cm² during a change in the consumption of water from 0 to 10 t/hs. In closed state the passage of the valve is virtually absent.

Pressure regulators of direct action cargo differ from pressure regulators of the type RD in the fact that in them the spring is replaced by load and is added the damping camera/chamber for preventing the vibrations. Regulators are produced by small batches with the diameters of internal diameter 50, 80 and 100 mm. Nonuniformity 0.5-0.8 kg/cm² during a change in the consumption from 0 to the nominal.

Temperature regulators of direct action RPD are utilized for maintenance within the assigned/prescribed limits of the temperature of the water, which enters the system of hot water supply. The thermal bulb of regulator is filled by the liquid the boiling point of which at the appropriate pressure somewhat lower than assigned/prescribed value of the adjustable temperature. During a change in the latter, changes the pressure of the saturated steams of this

liquid, which is led to the displacement/movement of control. In the case of the passage through the valve of the heating medium with elevated temperature, it is necessary to provide for air-conditioning of bellows control knob.

Regulators are manufactured to the following ranges of the adjustable temperature: 30-40; 40-50; 50-60; 60-70; 70-80; 80-90; 90-100; 100-110°C. Thermal bulb and housing are designed to conditional pressure 10 kg/cm². Basic data on these regulators are given in table 20.11.

The change in the temperature, necessary for displacing the valve from one end position to another (nonuniformity), composes 10°C.

The passage of valve in closed state with jump/drop 2 kg/cm² comprises for a valve with sealing cones to 0.2 l/min and for a valve without cones - to 1.2 l/min.

Due to the loose coverage of valve, large nonuniformity, frequent disturbance of the airtightness of thermometric system, the regulators RPD find very finding in thermal networks.

Temperature regulators of the type TRZh-3 (Fig. 20.17) are intended for maintaining the constant temperature of the mixed water at direct water selection and work on hydraulic two-nozzle principle. The thermal bulb of regulator is filled with transformer oil. The caused by a change in the temperature of the mixed water displacement/movement of the bottom of the bellows of thermal bulb is utilized for control of the passage of the governing water through forcing and drainage nozzles. As governing water is utilized the water from delivery pipe which after the passage of forcing and drainage nozzles is drawn off into the pipeline of the mixed water. Nonuniformity of regulator 2-4°C. Selection of temperature regulators of water of the type TRZh is done on table 20.12.

Table 20.9. Regulators of the type RR.

Диаметр условного прохода в мм (1)	Диаметр горловины седла в мм (2)	Максимальный ход клапана в мм (3)	Сильфон (4)		Размеры корпуса в мм (7)		Удельная пропускная способность по воде при $\Delta p_к = 1$ ат в т/ч* (10)
			наружный диаметр в мм (5)	эффективная площадь в $см^2$ (6)	длина (8)	высота (9)	
25	21,2	4	27	3,88	100	405	5
40	37,7	7	45	12	130	520	15
50	4[illegible],6	9	52	15,8	150	584	23
80	64	10	78	36,8	350	750	52
100	76	15	100	60	450	8[illegible]0	82

Key: (1). To diameter of the internal diameter in mm. (2). Diameter of the neck of saddle in mm. (3). Maximum valve travel in mm. (4). bellows. (5). outside diameter in mm. (6). effective area in cm². (7). Size/dimensions of housing in mm. (8). length. (9). height/altitude. (10). Specific throughput capacity in water when

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FOOTNOTE [1]. Specific throughput capacity (throughput capacity with loss of pressure in valve $\Delta p_к = 1$ at) is given for the completely open valve. ENDFOOTNOTE.

Table 20.10. Selection of the flow regulators of direct action of the type ßR.

(1) Расход воды в т/ч	(2) Регулируемый перепад давлений в ат для условных диаметров прохода корпуса в мм				
	25	40	50	80	100
0	2,2	1,8	—	—	—
2	1,9	1,6	2	—	—
4	—	1,4	1,9	—	—
6	—	—	1,7	—	—
8	—	—	1,6	2,1	—
10	—	—	1,5	2	—
15	—	—	—	1,9	—
20	—	—	—	1,7	1,8
25	—	—	—	1,6	1,7
30	—	—	—	1,5	1,7
35	—	—	—	—	1,6
40	—	—	—	—	1,5
45	—	—	—	—	1,5
50	—	—	—	—	1,4

Note: The regulated drop is given with complete compression of the spring.

Key: (1). Consumption of water in t/h. (2). Adjustable pressure differential in at for the conditional diameters of the pass of housing in mm.

Table 20.11. Temperature regulators of the type RPD.

(1) Диаметр условного прохода	(2) Размеры клапана в мм		(3) Диаметр золотника в мм			
			с уплотнением		без уплотнения	
	высота (4)	длина (5)	верхний (6)	нижний (7)	верхний (6)	нижний (7)
1"	326	140	26	24	25	25
1½"	3.5	170	50	48	50	50
2"	345	185	50	48	50	50

Key: (1). Diameter of the internal diameter. (2). Size/dimensions of valve in mm. (3). Diameter of valve in mm. (4). height/altitude. (5). length. (6). upper. (7). lower.

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Regulators are produced by diameter 25 and 40 mm. Are developed at present by ORGRES [ОРГРЭС - State Trust for the Organization and Rationalization of Regional Electric Power Plants and Networks] improved temperature regulators of the type TRD.

Temperature regulators of water of the heating system of Mosc power system Admin-ORGRES are intended for maintaining the constant temperature of the local water, coming out from the preheaters of hot water supply, and they are throttle type hydraulic regulators. In the assembly of regulator, they enter: thermorelay and throttle washer (measuring and command-amplifier organ/control), which controls valve with bellows drive of the type RR (common regulator of the type RR, see Fig. 20.16a), filter and the coolant of governing water.

Thermorelay is applied type BTR-2 with the bimetallic sensing element of construction of Thermal network of the Mosc power system Admin, but they can be applied also by thermorelay of other types. The nonuniformity of the bimetallic of the thermal of relay of type btr-2 composes 6-9°C, the drain of governing water 3-8 l/h.

As governing water is utilized the water from delivery pipe.

Controlling valve with bellows drive for temperature regulator is selected on curve/graph, given in Fig. 20.18.

Hydraulic regulator of the type RD-3a can be used for automatic pressure adjustment, consumption (the pressure differential) and of water level, and also for pressure adjustment pair.

Regulator is completed from the relay device RD-3a of developed ORGRES, and control valve with membrane/diaphragm servodrive.

Relay device consists of the standard assemblies whose combination is selected with assembly depending on the purpose of regulator. One of the modifications of the assembly of relay is given in Fig. 20.19. As governing medium is utilized water-conducting or network water, and also condensate. Drain of network water 50-100 l/h.

During the use as governing medium of network water, it is expedient to apply diagram with the bypass of this water (drainless diagram) utilizing pressure difference between feeding and return lines or the pressure differential in control valve. A minimum pressure differential in control valve in this case must comprise not less than 0.2-0.3 kg/cm².

Limits of deviations of the controlled parameters:

a) on pressure - from ± 0.03 to ± 0.08 kg/cm²;

b) on the pressure differential (consumption) - ± 0.07 kg/cm²;

c) on level - from 50 to 250 mm H_2O.

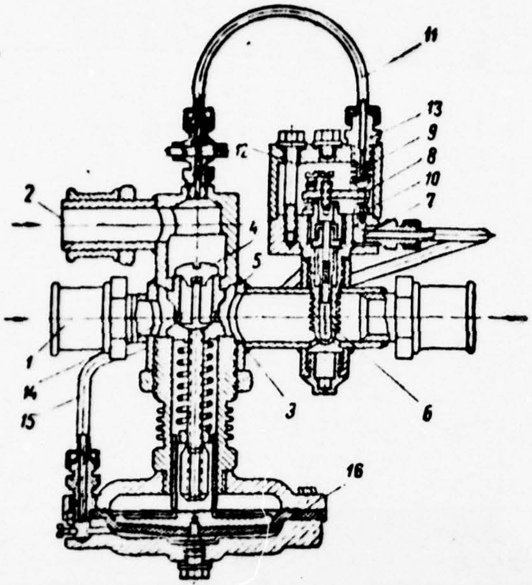

Fig. 20.17. Temperature regulator of type TRZh. 1 - branch connection for the entry of the cold water: 2 - branch connection for the entry of hot water; 3 - mixing chamber; 4 - valve of valve; 5 - limiting holes of valve; 6 - thermal bulb; 7 - bellows; 8 - lever; 9 - pressure nozzle; 10 - drainage nozzle; 11 - pulse tube; 12 - ball valve; 13 - camera/chamber of the governing pressure of the relay: 14 - internal camera/chamber of valve; 15 - pulse tube; 16 - lower chamber of membrane/diaphragm actuating mechanism.

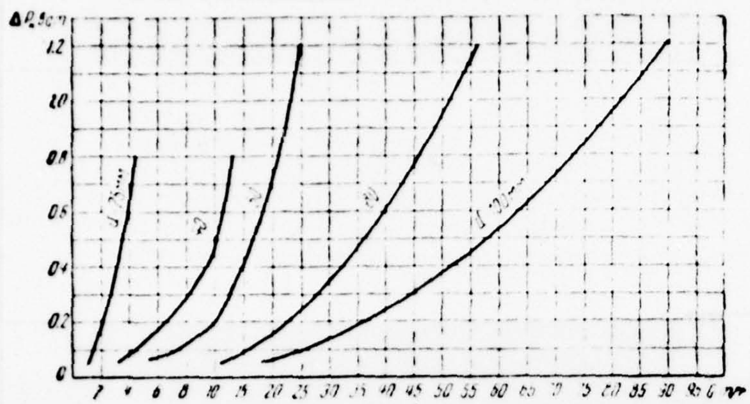

Fig. 20.18. Graph for selecting diameter of control valve with bellows drive of type RR. d - the diameter of the **internal diameter** in mm; G - the consumption of water in **t/h;** Δp_{κ} - **is the** pressure differential in control valve in **at.**

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Relay devices of the type RD-3a are produced by small batches. For a work in assembly with relay device RD, it is possible to utilize single-saddle control valves, developed by ORGRES. Graphs for selecting these control valves with membrane/diaphragm servodrive are given in Fig. 20.20.

Regulators of the type RD-3a can alsc work with control valves with bellows servodrive and with MIM membrane/diaphragm actuating mechanisms.

MIM membrane/diaphragm actuating mechanisms (Fig. 20.21) consist of membrane/diaphragm servodrive and the controlling two-saddle valve. These valves are manufactured for pneumatic regulators in two modifications: type VZ ("air is closed") and type VO ("air is opened").

Membrane/diaphragm drive is produced four size/dimensions: 1, 2, 3 and 4, moreover the drive of each size/dimension is intended for several conditions of passes. Basic data on MIM valves with valves (plungers) made of the stainless steel are given in table 20.13.

MIM valves are manufactured also with valves from brass to maximum temperature of 225°C.

Table 20.12. Table for selecting temperature regulator of water of the type TRZh.

Расчетный расход воды (1)		Диаметр ограничительных отверстий в мм (2)	Расчетный перепад давлений в клапане в кгс/см² (3)													
			1		2		3		4		5		6		7	
в л/сек	в т/ч		D	n	D	n	D	n	D	n	D	n	D	n	D	n
Условный диаметр корпуса d_y=25 мм (4)																
0,2	0,72	6	10	1	10	1	10	1	10	1	10	1	10	1	10	1
0,3	1,08	6	10	2	14	1	10	2	10	1	10	1	10	1	10	1
0,4	1,44	6	14	3	14	2	14	2	10	2	10	2	10	2	10	1
0,5	1,8	6	14	3	14	2	14	2	14	2	14	2	14	2	10	1
0,6	2,16	6	20	3	14	3	14	2	14	2	14	2	14	2	14	2
0,7	2,52	6	20	4	14	3	14	3	14	2	14	2	14	2	14	2
0,8	2,88	6	—	—	20	3	14	3	14	2	14	2	14	2	14	2
0,9	3,24	6	—	—	20	3	20	3	14	3	14	2	14	2	14	2
1	3,6	6	—	—	20	4	20	3	20	3	14	3	14	2	14	2
1,25	4,5	6	—	—	—	—	—	—	—	—	20	3	14	3	14	3
Условный диаметр корпуса d_y=40 мм (4)																
0,9	3,24	8	20	3	—	—	—	—	—	—	—	—	—	—	—	—
1	3,6	8	25	3	—	—	—	—	—	—	—	—	—	—	—	—
1,25	4,5	8	25	4	20	3	20	3	20	2	—	—	—	—	—	—
1,5	5,4	8	30	5	25	3	20	3	20	3	20	2	20	2	20	2
1,75	6,3	8	30	5	25	4	25	3	20	3	20	3	20	2	20	2
2	7,2	8	30	6	25	4	25	4	25	3	20	3	20	3	20	2
2,25	8,1	8	35	7	30	5	25	4	25	4	25	3	20	3	20	3
2,5	9	8	35	8	30	6	30	4	25	4	25	4	25	3	25	3
2,75	9,9	8	—	—	30	6	30	5	30	4	25	4	25	4	25	3
3,0	10,8	8	—	—	35	6	30	5	30	5	25	4	25	4	25	4
3,5	12,6	8	—	—	35	8	35	6	30	5	30	5	30	5	25	4

Conventional designations: D - the diameter of the flow area of valve seat in mm; d - the diameter of limiting holes in mm: n - the number of limiting hole.

Key: (1). Calculated consumption of water. (2). Diameter of limited opening in mm. (3). A design pressure differential in valve in kg/cm². (4). Conditional diameter of housing

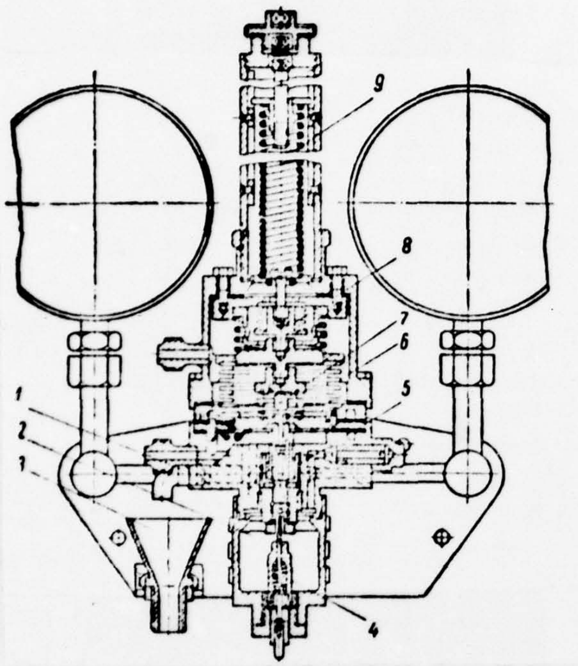

Fig. 20.19. Pressure relays of type RD-3a. 1 - base; 2 - settling tank; 3 - drainage funnel; 4 - blow-through valve with needle; 5 - control valve with throttle/choke, nozzle and shutter/valve; 6 - pulse bellows; 7 and 8 - bellows of glandless conclusion/derivations; 9 - tuning spring.

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During the use as governing medium of water with the pressure of more than 1.5 kg/cm^2, is required the replacement of the membrane/diaphragm cast iron camera/chambers by steel. For water it is more expedient to apply MIM valves with cylindrical valves and the shaped windows.

20.4. Telemechanization of thermal networks.

The questions of the telemechanization of thermal networks still only are develop/processed, in particular is conducted the development of new telemechanical equipment for thermal networks.

The telemechanization of the thermoficated installations of heat and power plant must be limited to emergency warning signaling and telemetering. The telemetering of pressure, temperature and consumption of network water, and also temperature of makeup water is realize/accomplished on call. Telemetering of consumption and pressure of supply

water must be continuous.

The volume of the telemechanization of pumping thermal networks is recommended to provide the following:

a) remote control from district point/item by pumps (control) and by catches on pressure line;

b) telesignalization of the position of equipment;

c) emergency preventive/warning remote signal system;

d) telemetering on the call of pressure, temperature and consumption.

For the controlled/inspected camera/chambers and the thermal point/items of users, is recommended to provide following volume of the telemechanization:

a) remote control from district point/item by catches;

b) telesignalization of the position of the remote-controlled equipment;

c) emergency-warning remote signal system.

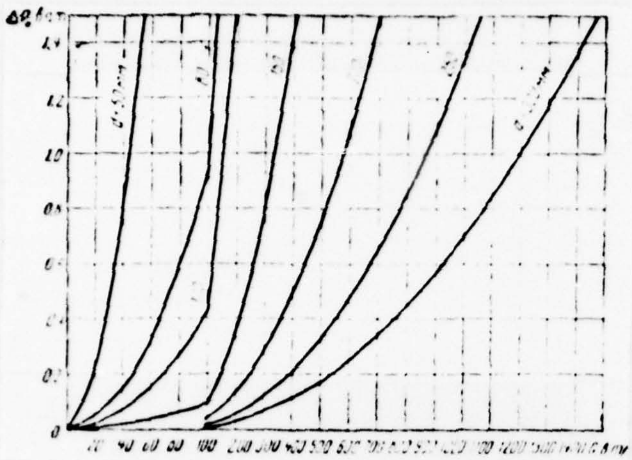

Fig. 21.20. Graph for selecting single-seat control valves for water by diameter 50-300 mm with membrane/diaphragm servodrive.

Table 20.13. MIM membrane/diaphragm actuating mechanisms.

Обозначение клапана (1)	(2) Условное давление в кГс/см²	(3) Предельная температура в °С	(4) Тип золотника (плунжера)	(5) Диаметр условного прохода в мм
24Ч[illegible]нж	16	300	(6) Сплошной двухседельный	25, 40, 50, 80, 100*
25Ч32нж	16	300		150*, 200*, 250*, 300*
25Ч[illegible]нж	16	200	(7) V-образный двухседельный	25, 50, 80, 100,
25Ч[illegible]нж	16	200		150, 200, 250, 300
25С[illegible]нж	64	300		25, 50, 80, 100,
25С5[illegible]нж	64	300		150, 200

Key: (1). Designation of valve. (2). Conditional pressure in kg/cm². (3). Maximum temperature even °C. (4). Type of

valve (plunger). (5). Diameter of the internal diameter in mm. (6). Solid two-saddle. (7). U-shaped two-saddle.

FOOTNOTE [1]. Are not produced in series. ENDFOOTNOTE.

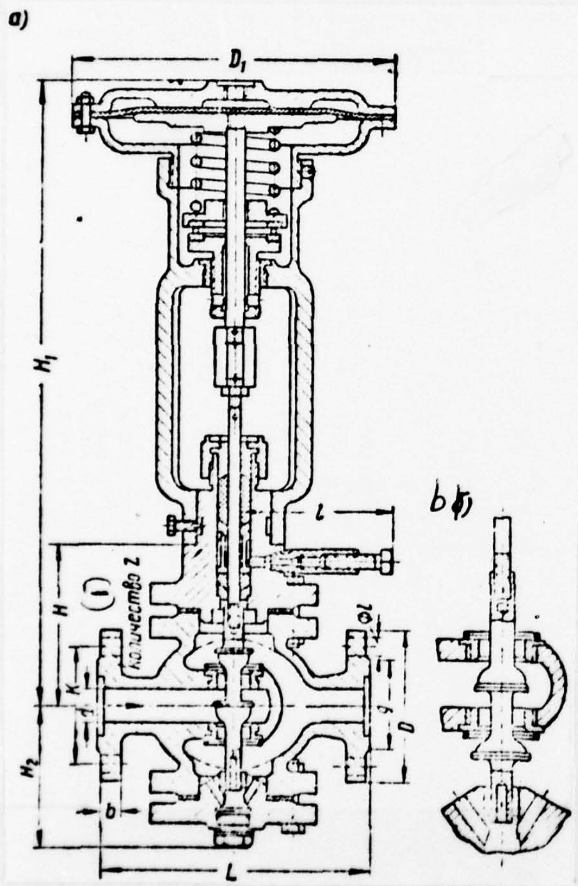

Fig. 20.21. Membrane/diaphragm executive mechanism of MIM type a) MIM-VZ-1 ("air is closed"); b) MIM-VO-1 ("air is open/disclosed").

Key: (1). Quantity.

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TECHNICAL AND ECONOMIC INDICES.

Chapter 21.

COMBINED TECHNICAL AND ECONOMIC INDICES.

The combined indices are comprised for a calculated thermal load from 0.5 to 600 gcal/h with the complete thermofication of cities and ~~settemnts~~ settlements with the calculated temperature of surrounding air -30°C.

All indices are given taking into account public building-up.

Specific technical and economic indices are given in table 21.1-21.3 with one source of heat and one heat carrier with the most widely used technical characteristics of networks, namely:

the roughness coefficient $K_{ш}$ for water lines 0.0005 m, for steam lines 0.0002 m and for condenser lines 0.0001 m;

a calculated temperature differential in the networks: water Δt = 80°C (on curve/graph 150/70°C), in steam r = 500 kcal/kg;

specific the loss of head to friction R_l = 5 kgf/m²;

the wall thickness of tubes on the assortment of the tubes of thermal networks, affirmed by the Ministry of power stations, with fittings of steel of domestic manufacture;

the structures of underground packing in blocked channels with suspended heat insulation in dry ground (on album of series TS-01-04);

specific thermal characteristics $\varkappa_{ж}$ of the residential and public buildings (in kcal/m³h):

(1) Многоэтажной застройки	0,33
2—3-этажной (2) »	0,38
Одноэтажной (3) »	0,42

Key: (1). There are much graduated building-up. (2). graduated. (3). Single-stage.

Table 21.1. Specific indices of mean diameters d and length of tubes L, of the expenditures of metal Z, of capital expenditures K.

(1) Расход тепла Q в Гкал/ч	(2) Теплоплотность q в Гкал/ч на 1 га	(3) Площадь застройки F в га	d в мм: $d^{ср}_{кв}$	$d^{ср}_{р}$	$d^{ср}_{м}$	$d^{ср}$	L в м на 1 Гкал/ч (4): $L_{кв.уд}$	$L_{р.уд}$	$L_{м.уд}$	$L_{уд}$	Z в т на 1 Гкал/ч (4): $Z_{кв.уд}$	$Z_{р.уд}$	$Z_{м.уд}$	$Z_{уд}$	K в тыс. руб. на 1 Гкал/ч (4): $K_{кв.уд}$	$K_{р.уд}$	$K_{м.уд}$	$K_{уд}$
1	0,2	5	38	61,1	—	48	1770	360	—	2130	10,4	3,54	—	13,94	23,8	5,3	—	29,1
	0,35	2,66	52	—	—	52	635	—	—	635	5,3	—	—	5,3	9,3	—	—	9,3
	0,47	2,13	74	—	—	74	376	—	—	376	4,57	—	—	4,57	6,4	—	—	6,4
	0,71	1,41	83	—	—	83	253	—	—	253	3,55	—	—	3,55	4,5	—	—	4,5
5	0,2	25	38	87	—	55,3	1770	964	—	2734	10,4	14,2	—	24,6	23,8	17,8	—	41,6
	0,38	13,3	60	149	—	65,3	700	44	—	744	6,75	1,1	—	7,85	11,3	0,9	—	12,2
	0,47	10,65	88	173	—	91,5	435	18,6	—	453,6	6,48	0,65	—	7,13	8	0,7	—	8,7
	0,71	7,05	102,1	—	—	102,1	304	—	—	304	4,9	—	—	4,9	5,9	—	—	5,9
10	0,2	50	38	109	—	62,6	1770	936	—	2706	10,4	16,1	—	26,5	23,8	19,6	—	43,4
	0,38	26,6	60	165	—	72	700	86	—	786	6,75	2,86	—	9,61	11,3	2,2	—	13,5
	0,47	21,3	88	191	—	101	435	50,7	—	485,7	6,48	1,95	—	8,43	8	1,4	—	9,4
	0,71	14,1	106	210	—	111	304	14,4	—	318,4	5,1	0,67	—	5,77	6,2	0,5	—	6,7
25	0,2	125	38	147 / 99,5	— / 222,5	72,8	1770	844 / 521	— / 323	2614	10,4	21,68 / 8,78	— / 15,9	35,08	23,8	22 / 11	— / 11	45,8
	0,38	66,5	60	152 / 157,5	— / 222,5	82,6	700	145 / 64	— / 81	845	6,75	6,02 / 2,04	— / 3,98	12,77	11,3	3,9 / 1,5	— / 2,4	15,2
	0,47	53,25	88	213,5	—	113	435	101	—	536	6,48	4,76	—	11,24	8	3,1	—	11,1
	0,71	35,25	106	238	—	123,8	304	47	—	351	5,1	2,46	—	7,56	6,2	1,6	—	7,8
50	0,2	250	38	122,5	254	82,3	1770	489,4	350,2	2609,6	10,4	9,5	19,4	39,3	23,8	11,1	12,8	48
	0,38	133	60	185	254	91,2	700	61	98,4	862,1	6,75	2,38	5,48	14,61	11,3	1,8	3,5	16,6
	0,47	106,5	88	242,5 / 216	— / 254	124	435	132,2 / 42	— / 90,2	567,2	6,48	7,0 / 2,0	— / 5	13,48	8	4,7 / 1,25	— / 3,25	12,5
	0,71	70,5	106	259	—	135	304	72,6	—	376,6	5,1	4,15	—	9,25	6,2	2,6	—	8,8

Key: (1). Heat consumption Q in gcal/h. (2). Heat-density q in gcal/h on 1 hect. (3). Area of building-up F in hect. (4). Gcal/h.

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Continuation of table 21.1.

Расход тепла Q в Гкал/ч (1)	Теплоплотность q в Гкал/ч на 1 га (2)	Площадь застройки F в га (3)	d в мм				L в м на 1 Гкал/ч (4)				Z в т на 1 Гкал/ч (4)				K в тыс. руб. на 1 Гкал/ч (5)			
			$d^{cp}_{кв}$	$d^{cp}_{р}$	$d^{cp}_{м}$	d^{cp}	$L_{кв.уд}$	$L_{р.уд}$	$L_{м.уд}$	$L_{уд}$	$Z_{кв.уд}$	$Z_{р.уд}$	$Z_{м.уд}$	$Z_{уд}$	$K_{кв.уд}$	$K_{р.уд}$	$K_{м.уд}$	$K_{уд}$
100	0,38 0,47 0,71	266 213 141	60 88 106	206 240 $\frac{206}{279}$	302 302 $\frac{—}{302}$	101,7 138,6 149	700 435 304	64 42 $\frac{92,2}{22,95}$	116,8 105,5 $\frac{—}{69,25}$	880,8 583,5 396,2	6,75 6,48 5,1	2,66 2,01 $\frac{6,9}{1,62}$	8,9 8,05 $\frac{—}{5,28}$	18,31 16,54 12	11,3 8,0 6,2	1,85 1,35 $\frac{3,85}{0,85}$	5 4,4 $\frac{—}{3}$	18,15 13,75 10,95
200	0,38 0,47 0,71	532 426 282	60 88 106	216 250 287,5	356 356 355	114,1 153,7 165,1	700 435 304	64 42 24,85	135 119,3 78,65	899 596,3 407,5	6,75 6,48 5,1	3,65 2,3 1,81	13,4 11,8 7,8	23,2 20,58 14,71	11,3 8 6,2	1,9 1,4 1	6,8 5,9 4	20 15,3 11,2
400	0,47 0,71	852 564	88 106	262 295,5	432 432	175,1 185,7	435 304	42 26,1	132 86,2	609 416,3	6,48 5,1	2,78 1,95	11,8 7,72	21,06 14,77	7,9 6,2	1,55 1,06	8,15 5,54	17,6 12,8
600	0,71	846	106	300	491,5	197	304	26,1	87,3	417,4	5,1	1,98	6,96	16,04	6,2	1,08	6,32	13,8

Designations: kv - quarterly networks; r - distribution networks; m - supply mains.

Note. In antecedent, are taken into account indices L, Z and K of supply mains with diameter to 250 mm, in denominator are given only the indices on transfer or supply mains.

Key: (1). Heat consumption Q in gcal/h. (2). Heat-density q in gcal/h on 1 hect. (3). Area of development F in hect. (4). In m on gcal/h.

Table 21.2. Specific indices of the expenditures of metal Z_{TP} and of capital expenditures K_{TP} on two-funnelled transit and district thermal networks at the length of route 1 km.

(1) Диаметр транзитной сети $d_{тр}$ в мм	(2) Расчетный расход тепла Q в Гкал/ч	$Z_{тр}$ в т на 1 Гкал/ч (3)	$K_{тр}$ в тыс. руб. на 1 Гкал/ч (5)
200	5,65 10,5	14,75 7,93	10,26 6,52
250	10,5 18,5	10,85 6,17	6,77 3,83
300	18,5 28,8	8,41 5,42	4,58 2,95
350	28,8 43,5	6,98 4,62	3,4 2,25
400	43,5 60	3,91 2,83	2,58 1,87
450	60 80	3,23 2,42	2,1 1,575

Key: (1). Diameter of transit network d_{TP} in mm. (2). Calculated heat consumption Q in gcal/h. (3). Z_{TP} in t on 1 gcal/h.

Continuation table 21.2.

Continuation table 21.2.

Диаметр транзитной сети $d_{тр}$ в мм (1)	Расчетный расход тепла Q в Гкал/ч (2)	$Z_{тр}$ в т на 1 Гкал/ч (3)	$K_{тр}$ в тыс. руб. на 1 Гкал/ч (3)
500	80 107	2,71 2,02	1,752 1,31
600	107 180	1,95 1,16	1,57 0,934
700	180 242	1,93 1,44	1,11 0,826
800	242 316	1,78 1,36	0,93 0,712
900	316 430	1,69 1,24	0,823 0,6[illegible]5
1000	430 600	1,5 1,075	0,668 0,478
1100	600	1,27	0,52

Key: (1). Diameter of transit network in mm. (2). Calculated heat consumpticn Q in gcal/h. (3). in t on 1 gcal/h.

Table 21.3. Specific indices of the thermal networks of cities, referred on 1 m² by the vein/strand of area, on 1 m³ of the construction volume of habitable buildings and to 1 inhabitant.

(1) Максимальный часовой расход тепла в Гкал/ч	(2) Теплоплотность в Гкал/ч га	Удельные показатели, отнесенные на (3)								
		1 м² жилплощади (4)			1 м³ строительного объема жилых зданий (5)			1 жителя (6)		
		L в м/м² (7)	K в руб/м² (8)	Z в кг/м² (9)	L в м/10³/м³	K в руб/м³ (8)	Z в кг/м³ (9)	L в м/жит (10)	K в руб/жит (11)	Z в кг/жит (12)
1	0,2 0,38 0,47 0,71	0,422 0,124 0,074 0,046	5,77 1,82 1,25 0,814	2,76 1,03 0,892 0,642	70,4 18,9 11,4 6,6	0,963 0,28 0,193 0,116	0,46 0,159 0,137 0,0917	5,07 1,19 0,88 0,55	69,3 21,3 15,0 9,76	33,2 12,4 10,7 7,7
5	0,2 0,38 0,47 0,71	0,54 0,145 0,089 0,055	8,25 2,38 1,7 1,07	4,87 1,53 1,39 0,885	90 22,3 13,7 7,9	1,38 0,366 0,262 0,153	0,811 0,236 0,214 0,126	6,5 1,74 1,06 0,66	99 28,6 20,4 12,8	58,5 18,4 16,7 10,6

Key: (1). Maximum hourly consumption of heat in gcal/h. (2). Heat-density in gcal/h hect. (3). Specific indices, referred on. (4). 1 m² of living space. (5). 1 m³ construction volume of habitable buildings. (6). 1 inhabitant. (7). L in m/m². (8). K in rubles/m². (9). Z in kg/m². (10). in m/inhabitant. (11). in rubles/inhabitant. (12). in kg/inhabitant.

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The indices of table 21.1 encompass thermal networks in the range of the area of building-up, in this case the heat source is placed at its boundary/interfaces.

For technological steam lines these indices can be used during the even distribution of thermal load according to the area of building-up.

In the cost/value of the packing of thermal networks and into the expenditures of metal on thermal networks are included the cost/value and the expenditures of metal on all the structural, assembling and insulation constructions not only on strictly networks, but also on the camera/chambers, the assemblies, the compensators and other cell/elements of thermal networks.

For obtaining technical and economic indices of the thermal networks which differ from the networks, laid strict conformity with technical specifications and specific characteristics (see Table 21.1-21.3), are given coefficients and formulas for a conversion (table 21.4-21.7).

Continuation table 21.3.

Максимальный часовой расход тепла в Гкал/ч (1)	Теплоплотность в Гкал/га (2)	Удельные показатели, отнесенные на (3)								
		1 м² жилплощади (4)			1 м³ строительного объема жилых зданий (5)			1 жителя (6)		
		L в м/м²	K в руб/м²	Z в кг/м²	L в м·10⁻³/м³	K в руб/м³	Z в кг/м³	L в м/жит	K в руб/жит	Z в кг/жит
10	0,2 0,38 0,47 0,71	0,54 0,153 0,065 0,058	8,6 2,64 1,83 1,22	5,26 1,88 1,64 1,04	90 23,6 11,6 8,3	1,44 0,406 0,282 0,175	0,88 0,29 0,252 0,149	6,45 1,84 1,14 0,69	163 31,6 22 14,6	63,2 22,5 19,7 12,5
25	0,2 0,38 0,47 0,71	0,52 0,165 0,105 0,064	9,1 2,96 2,16 1,41	6,95 2,49 2,19 1,57	86,7 25,4 16,2 9,2	1,52 0,456 0,332 0,202	1,16 0,384 0,338 0,196	6,22 1,98 1,26 0,76	109 35,6 25 16,9	83,5 29,9 26,3 16,4
50	0,2 0,38 0,47 0,71	0,51 0,168 0,111 0,069	9,5 3,24 2,43 1,59	7,8 2,86 2,62 1,68	85 25,8 17,1 9,9	1,58 0,499 0,374 0,228	1,3 0,44 0,404 0,24	6,11 2,02 1,33 0,82	114 38,8 29,2 19,1	93,5 34,2 31,5 20,1
100	0,38 0,47 0,71	0,172 0,111 0,072	3,54 2,68 1,82	3,57 3,24 2,16	26,5 17,6 10,3	0,545 0,412 0,26	0,55 0,499 0,309	2,06 1,37 0,86	42,5 32,2 21,8	42,9 38,8 26
200	0,38 0,47 0,71	0,175 0,117 0,074	3,9 2,69 2,02	4,53 4,01 2,67	27 18 10,6	0,6 0,414 0,288	0,697 0,618 0,382	2,1 1,4 0,845	46,9 32,3 24,3	54,4 48,2 32
400	0,47 0,71	0,119 0,075	3,11 2,32	4,1 2,68	18,3 10,7	0,53 0,332	0,63 0,384	1,425 0,905	41,2 27,8	49,3 32,1
600	0,71	0,076	2,5	2,9	10,9	0,357	0,415	0,906	30,0	34,8

Note. Specific indices are calculated with the norm of inhabited area 12 m²/person: volume coefficients -6 mm² for q equal to 0.2, 6.5 ¹m¹ for q, different 0.8 and 0.17 ¹ ¹ for q = of 0.71; heat rates of 2320 kcal/h man for q = 0.2, 2270 kcal/h man for q, are equal to 0.33 an 0.47 2106 kcal/h man for q = of 0.71; during common/general/total heat distribution from heat and power

plant taking into account the setting up of peak boilers 3 thous. kcal/kW.

Key: (1). Maximum racial heat consumption in gcal/h. (2). Heat-density in gcal/h hect. (3). Specific indices, referred to. (4). 1 m³ of inhabitated area. (5). 1 m³ of the construction volume of habitable buildings. (6). inhabitant.

Table 21.4. Correction factors for $K_{уд}$ and $Z_{уд}$ for the different types of channels and thermal tubular insulation.

Характеристика (1)	Обозначение показателя (2)	Для средних диаметров труб в мм (3)								
		25	50	100	200	300	400	500	600	700
Непроходные каналы для мокрых грунтов с попутным дренажом, стены из бетонных блоков, основание — бетонные плиты, грунт мокрый; изоляция — подвесная из менеральной ваты (4)	$K_{уд}$	2,32	2,09	1,82	1,66	1,46	1,35	1,29	1,25	1,22
	$Z_{уд}$	1,01	1,01	1,01	1,01	1,01	1,01	1,01	1,01	1,01

Key: (1). Characteristic. (2). Designation of index. (3). For the mean diameters of tubes in mm. (4). Impassable channels for wet soils with incidental drainage; wall from concrete blocks, base is concrete slabs; soil wet, isolation/insulation - presented from minearal cotton.

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Continuation table 21.4.

Характеристика (1)	Обозначение показателя (2)	Для средних диаметров труб в мм (3)								
		25	50	100	200	300	400	500	600	700
Непроходные каналы для сухих песчаных грунтов, стены из бетонных блоков, основание железобетонное по бетонной подготовке, изоляция подвесная из минеральной ваты (4)	$K_{уд}$	1,21	1,18	1,13	1,2	1,13	1,1	1,08	1,065	1,06
	$Z_{уд}$	1,005	1,005	1,005	1,005	1,005	1,005	1,005	1,005	1,005
Непроходные каналы для сухих и хорошо фильтрующихся грунтов; стены из бетонных блоков, основание — бетонные плиты; изоляция засыпная из минеральной ваты (5)	$K_{уд}$	0,77	0,76	0,75	0,8	0,84	0,815	0,85	0,855	0,86
	$Z_{уд}$	0,865	0,957	0,907	0,942	0,953	0,957	0,957	0,963	[illegible]

note. For the channels Of a series IS 01-04 brands KL60-30, 2kl 60-60, the correction factor for cost is equal to 1.5.

Key: (1). Characteristic. (2). Designation of index. (3). For the mean diameters of tubes in mm. (4). Key Illigible. (5). Key Illigible.

Table 21.5. The correction factors of capital expenditures cn thermal networks in tariff belt/zones.

Тарифные пояса (1)	Поясные коэффициенты (2)
I	1
II	1,1
III	1,2
IV	1,4
Магаданская область: Чукотский национальный округ, Сахалинская область — все местности, за исключением Курильских островов, Хабаровский край, Камчатская область (3)	2
Сахалинская область и Курильские острова (4)	2,5

Key: (1). Tariff belt/zones. (2). Zonal coefficients. (3). Magadan field: Chukot National district, Sakhalin field is all localities, with the exception of the Kurile Islands. Khabarovsk edge, Kamchatka field. (4). Sakhalin field and the Kurile Islands.

Table 21.6. Formulas for determining of specific material indices and the operating costs from thermal networks.

Наименование удельных показателей (1)	Формула (2)
Средний диаметр в м (3)	$d^{cp} = 3{,}4 \div BQ^{0,38}$
Длина трубопроводов в м (4)	$L_{уд} = \frac{L}{Q} = \frac{M_{уд}}{d^{cp}}$
Затраты металла в кг на 1 Гкал/ч (5)	$Z_{уд} = \frac{Z}{Q} = z^{cp} L_{уд} = \left(z_{т}^{cp} + z_{ит}^{cp} \right) L_{уд} = [E + (2400 + H) d^{cp}] L_{уд}$
Капитальные затраты в руб. (6)	$K_{уд} = \frac{K}{Q} = k^{cp} L_{уд} = (a + bd^{cp}) L_{уд}$

Key: (1). Designation of specific indices. (2). Formula. (3). The mean diameter in m. (4). Long pipelines in m. (5). Expenditures of metal in kg on 1 gcal/h. (6). Capital expenditures in rubles.

Table 21.7. Formulas for determining the average calculated temperature of heat carrier $\Delta t°C$ at the conversion of the technical and economic indices.

Наименование схемы и температурного графика (1)	Формула (2)
1. Водяные двухтрубные тепловые сети (3)	Общая: (4) $\Delta t = \frac{1{,}41Q}{\sqrt{G^2_{\text{под}} + G^2_{\text{обр}}}} =$ $= \frac{1{,}41(Q_{\text{от}} + Q_{\text{в}} + Q_{\text{г.в}})}{\sqrt{\left(\frac{Q_{\text{от}}}{\Delta t_{\text{от}}} + \frac{Q_{\text{в}}}{\Delta t_{\text{в}}} + \frac{Q_{\text{г.в}}}{\Delta t_{\text{г.в}}}\right)^2 + \left(\frac{Q_{\text{от}}}{\Delta t_{\text{от}}} + \frac{Q_{\text{в}}}{\Delta t_{\text{в}}} + \frac{Q_{\text{г.в}}}{\Delta t_{\text{г.в}}}\right)^2}}$
а) закрытая система горячего водоснабжения, работающая по обычному температурному графику (5)	$\Delta t = \frac{1 + \Omega_{\text{в}} + \Omega_{\text{г.в}}}{\frac{1}{\Delta t_{\text{от}}} + \frac{\Omega_{\text{в}}}{\Delta t_{\text{в}}} + \frac{2\Omega_{\text{г.в}}}{\Delta t_{\text{г.в}}}}$
б) то же, с аккумулятором (6)	$\Delta t = \frac{1 + \Omega_{\text{в}} + \Omega_{\text{г.в}}}{\frac{1}{\Delta t_{\text{от}}} + \frac{\Omega_{\text{в}}}{\Delta t_{\text{в}}} + \frac{\Omega_{\text{г.в}}}{\Delta t_{\text{г.в}}}}$
в) закрытая система горячего водоснабжения с установкой подогревателей последовательно на подающей и обратной трубах; открытая система горячего водоснабжения; в том и другом случае системы работают по графику с температурной надбавкой (7)	$\Delta t = \frac{1 + \Omega_{\text{в}} + \Omega_{\text{г.в}}}{\frac{1}{\Delta t_{\text{от}}} + \frac{\Omega_{\text{в}}}{\Delta t_{\text{в}}}}$

Key: (1). Designation of diagram and temperature graph. (2). Formula. (3). Water two-funnelled thermal networks. (4). General. (5). the closed system of hct water supply, is working on common temperature graph. (6). the same, with storage battery/accumulator. (7). the closed system of hot water supply with the setting up of subheaders consecutively on feeding and reverse/inverse pipes: the open system of hot water supply; in both cases of system they work on

curve/graph with temperature increase.

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For determining final cost of thermal networks, it is necessary to basic expenditures (see table 21.1-21.3) to add the additional expenditures, given in table 21.8.

Table 21.7 gives the following designations: $Q_{от}, Q_{в}, Q_{г.в}$ and $G_{от}, G_{в}, G_{г.в}$ — maximum hourly consumptions of heat and water respectively for heating and ventilation, and also hourly mean the heat consumption and water for hot water supply in gcal/h and kg/h;

$\Delta t_{от}, \Delta t_{в}, \Delta t_{г.в}$ — calculated temperature differentials to heating, ventilation and hot water supply; $\Omega_{в} = \frac{Q_{в}}{Q_{от}}$; $\Omega_{г.в} = \frac{Q_{г.в}}{Q_{от}}$ — - relation of calculated heat consumption; $t_{к}$ and $t_{в}$ — are temperature of condensate and tap water in °C;

$\Delta t_{таб.т.в}$ — the calculated temperature for water lines, accepted during the compilation of tables; Ж = 0.31 - 0.61; in this case for the steam lines:

с $P = 4 \div 6$ ата (1) и $\gamma_{ср} = 2$ кг/м³ Ж = 0,31
» $P = 10$ » » $\gamma_{ср} = 4$ » Ж = 0,44
» $P = 20$ » » $\gamma_{ср} = 8$ » Ж = 2,61

Key: (1). atm(abs.) and.

Table 21.7.

Наименование схем и температурного графика (1)	Формула (2)
г) открытая система горячего водоснабжения с аккумуляторами у потребителей, работающая по графику с температурной надбавкой (3)	$\Delta t = \frac{1{,}41\,(1+\Omega_{в}+\Omega_{г.в})}{\sqrt{\left(\frac{1}{\Delta t_{от}}+\frac{\Omega_{в}}{\Delta t_{в}}\right)^{2}+\left(\frac{1}{\Delta t_{от}}+\frac{\Omega_{в}}{\Delta t_{в}}-\frac{\Omega_{г.в}}{\Delta t_{г.в}}\right)^{2}}}$
д) открытая система горячего водоснабжения, работающая по обычному графику (4)	$\Delta t = \frac{1{,}41\,(1+\Omega_{в}+\Omega_{г.в})}{\sqrt{\left(\frac{1}{\Delta t_{от}}+\frac{\Omega_{в}}{\Delta t_{в}}+\frac{\Omega_{г.в}}{\Delta t_{г.в}}\right)^{2}+\left(\frac{1}{\Delta t_{от}}+\frac{\Omega_{в}}{\Delta t_{в}}\right)^{2}}}$
2. Водяные однотрубные тепловые сети (5)	(6) Общая: $\Delta t = \frac{Q}{G_{от}+G_{в}+G_{г.в}} = \frac{Q_{от}+Q_{в}+Q_{г.в}}{\frac{Q_{от}}{\Delta t_{от}}+\frac{Q_{в}}{\Delta t_{в}}+\frac{Q_{г.в}}{\Delta t_{г.в}}}$
а) с обеспечением теплом всех потребителей при $G_{г.в} < G_{от}+G_{в}$ (7)	$\Delta t = \frac{1+\Omega_{в}+\Omega_{г.в}}{\frac{1}{\Delta t_{от}}+\frac{\Omega_{в}}{\Delta t_{в}}}$
б) с расходом в них воды, равным расходу воды на горячее водоснабжение (8)	$\Delta t = \frac{\Delta t_{г.в}\,(1+\Omega_{в}+\Omega_{г.в})}{\Omega_{г.в}}$
3. Конденсатопроводы (9)	$\Delta t_{к} = t_{к} - t_{в}$
4. Паропроводы (10)	$\Delta t_{экв} = Ж\,\Delta t_{табл.в}$

Key: (1). Designation cf diagrams and temperature graph. (2). Formula. (3). d) the open system of hot water supply with storage battery/accumulators of users, is working on curve/graph with temperature increase. (4). e) open system of hot water supply, is working on common graph. (5). Water single-pipe thermal networks. (6). general. (7). with provision of heat of all users with. (8). b) with the consumption in them of water, equal to the consumption of

water for hot water supply. (9). condensers. (10). Steam lines.

Continuation table 21.8.

Наименование работ (1)	Единица измерения (2)	Стоимость (3)
Гараж на 5 машин: (4)	(7)	
а) строительная часть (5)	1 здание	14,84 »
б) автомашины (6)	1 автомашина (8)	7 »
Подготовка территории (трассы) строительства, снос строений, перекладка коммуникаций, разборка и восстановление мостовых: (9)		
а) для Москвы, Ленинграда, Киева, Харькова и крупных городов с существующей застройкой и сложной большой насыщенностью подземных хозяйств (10)	(11) % от стоимости объектов основного производственного назначения (гл. 2 сводного сметно-финансового расчета)	8%
б) для прочих городов (12)	то же (13)	6%
в) для жилых поселков (14)	»	4%
Временные здания и сооружения (15)	»	1,5%
Возврат материалов от временных зданий и сооружений (16)	»	15%
Удорожание, связанное с производством работ в зимнее время, для строек, расположенных в температурных зонах: (17)		
I	(18) % от стоимости затрат, включенных в I часть сводного сметно-финансового расчета	1,1%
II	то же (13)	2%
III	»	3,7%
IV	»	4,9%
V	»	7%
VI (19)	»	9%
Затраты, связанные с применением прогрессивно-премиальной оплаты труда	(20) % от полной стоимости строительно-монтажных работ	0,5%
Непредвиденные работы и затраты при двухстадийном проектировании (21)	% от полной стоимости строительства (22)	3%

Key: (1). Designation of works. (2). Unit of measurement. (3). Cost/value. (4). Garage of 5 machines. (5). a) construction unit. (6) b) motor vehicle. (7). building. (8). motor vehicle. (9). Training/preparation of the territory

(trass) of building, the removal/drift of structures, reversal of communications, dismantling and the restoration/reduction of bridge. (10). for Moscow, Leningrad, Kiev, Kharkov and large cities with the existing building-up and the complex large saturation of underground economies. (11). from the cost/value of the objects of basic production designation/purpose (chapter 2 of compound plans and financial calculation). (12). for other cities. (13). the same. (14). for habitable settlements. (15). Time/temporary buildings and constructions. (16). Return of materials from time/temporary buildings and constructions. (17). Rise in price, connected with the production of works in winter, for the buildings, arrange/located in temperature zones. (18). from the cost/value of the expenditures, connected 1 part of the compound plans and financial calculation. (19). Expenditures, connected with the application/use of progressive-bonus remuneration of work. (20). from final cost of the construction-assembly works. (21). Unforeseen works and expenditures during two-stage planning. (22). from final cost of building.

table 21.8. Objects of the subsidiary production and operating designation/purpose and other works and expenditures.

Наименование работ (1)	Единица измерения (2)	Стоимость (3)
Районный пункт управления теплосети с ремонтно-механической мастерской (4)	1 пункт (5)	78,7 тыс. руб. (6)
Дренажная подземная насосная станция объемом 50 $м^3$ с учетом сантехнических работ и освещения (7)	1 станция (8)	1,53 »
Механическая и ремонтная мастерская с оборудованием (9)	1 мастерская (10)	18,3 »

Key: (1). Designation of work. (2). Unit of measurement. (3). Cost/value. (4). District control post of heating system from repair and mechanical shop. (5). point/item. (6). thous. rubles. (7). Drainage underground pumping station with volume 50 m^3. (8). Station. (9). Mechanical and repair shop with equipment. (10). Shop.

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Table 21.6 gives the following designations: $\frac{d^{ср}}{d^{н}}$ **(where** $d^{н}$ – **is the** initial diameter of main line with the calculated thermal load);

$$B = \frac{K_{ш}^{0.0476}}{\gamma^{0.19} R_l^{0.19} \Delta t^{0.38}};$$

$K_{ш}$ – a **roughness** factor;

Δt - the calculated temperature differential, determined by table 21.7;

$z_{т}^{ср}$ — expenditure of metal on 1 m of steel tubes in kg/m;

$z_{нт}^{ср}$ — the same, on 1 m nontube of that composing in kg/m;

E and H are the constant coefficients, accepted during compilation table 21.1 and 21.2 for tubes by the diameter:

25—300 мм	$E = 1,5;$	$H = 46,7$
300—500 »	$E = -7,3;$	$H = 76$
500—700 »	$E = -14,7;$	$H = 80$

δ - the wall thickness of tubes in m;

a and b - the constant coefficients accepted during compilation table 21.1 and 21.2 for tubes by the diameter:

(1) до 150 мм	$a = 9,6;$	$b = 100$
200—700 »	$a = 0;$	$b = 140,5$

Key: (1). To.

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